

# Package ‘Signac’

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**Title** Analysis of Single-Cell Chromatin Data

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**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. Reference: Stuart et al. (2020) <doi:10.1101/2020.11.09.373613>.

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**License** MIT + file LICENSE

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**URL** <https://github.com/timoast/signac>, <https://satijalab.org/signac>

**BugReports** <https://github.com/timoast/signac/issues>

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**Imports** GenomeInfoDb, GenomicRanges, IRanges, Matrix, Rsamtools, S4Vectors, Seurat (>= 3.2.0), SeuratObject, data.table, dplyr (>= 1.0.0), future, future.apply, ggplot2, ggseqlogo, irlba, pbapply, tidyr, patchwork, stats, utils, BiocGenerics, Biostrings, ggrepel, stringi, ggbio, biovizBase, AnnotationFilter, fastmatch, lsa, RcppRoll, scales, Rcpp, ggforce

**Collate** 'RcppExports.R' 'data.R' 'generics.R' 'dimension\_reduction.R' 'footprinting.R' 'fragments.R' 'genomeinfodb-methods.R' 'granges-methods.R' 'iranges-methods.R' 'links.R' 'mito.R' 'motifs.R' 'objects.R' 'peaks.R' 'preprocessing.R' 'quantification.R' 'utilities.R' 'visualization.R'

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**NeedsCompilation** yes

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---

AccessiblePeaks	<i>Accessible peaks</i>
-----------------	-------------------------

---

**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

<code>object</code>	A Seurat object
<code>features</code>	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.
<code>genome</code>	A BSgenome object
<code>assay</code>	Name of assay to use. If NULL, use the default assay.
<code>verbose</code>	Display messages
<code>...</code>	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 object
pfm	A PFMatrixList object
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	<i>Quantify aggregated genome tiles</i>
----------------	---

---

### 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,  
  assay = NULL,  
  new.assay.name = "tiles",  
  min_counts = 5,  
  binsize = 5000,  
  verbose = TRUE,  
  ...  
)  
  
## S3 method for class 'ChromatinAssay'  
AggregateTiles(  
  object,  
  genome,  
  min_counts = 5,  
  binsize = 5000,  
  verbose = TRUE,  
  ...  
)  
  
## Default S3 method:  
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	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**

```
AlleleFreq(object, ...)
```

```
## Default S3 method:
```

```
AlleleFreq(object, variants, ...)
```

```
## S3 method for class 'Assay'
```

```
AlleleFreq(object, variants, ...)
```

```
## S3 method for class 'Seurat'
```

```
AlleleFreq(object, variants, assay = NULL, new.assay.name = "alleles", ...)
```



**Arguments**

object	A Seurat object, Assay, or matrix
...	Arguments passed to other methods
variants	A character vector of informative variants to keep. For example, <code>c("627G&gt;A", "709G&gt;A", "1045G&gt;A", "17</code>
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.

---

 Annotation

*Annotation*


---

**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 <a href="#">GRanges</a> 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)
Annotation(atac_small[["peaks"]]) <- genes
genes <- Annotation(atac_small)
Annotation(atac_small) <- genes
```

---

AnnotationPlot	<i>Plot gene annotations</i>
----------------	------------------------------

---

**Description**

Display gene annotations in a given region of the genome.

**Usage**

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

**Arguments**

object	A <a href="#">Seurat</a> object
region	A genomic region to plot

**Value**

Returns a [ggplot](#) object

**Examples**

```
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 <a href="#">ChromatinAssay</a>
...	Arguments passed to other methods
ranges	A <a href="#">GRanges</a> object
seqinfo	A <a href="#">Seqinfo</a> 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 <a href="#">Motif</a> object
fragments	A list of <a href="#">Fragment</a> 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	<i>A small example scATAC-seq dataset</i>
------------	---

---

**Description**

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

**Usage**

```
atac_small
```

**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](https://support.10xgenomics.com/single-cell-atac/datasets/1.1.0/atac_v1_pbmc_10k)

---

AverageCounts	<i>Average Counts</i>
---------------	-----------------------

---

**Description**

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

**Usage**

```
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**

```
AverageCounts(atac_small)
```

---

BinarizeCounts	<i>Binarize counts</i>
----------------	------------------------

---

## 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)
```

---

blacklist\_ce10      *Genomic blacklist regions for C. elegans ce10*

---

**Description**

Genomic blacklist regions for C. elegans ce10

**Usage**

blacklist\_ce10

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

blacklist\_ce11      *Genomic blacklist regions for C. elegans ce11*

---

**Description**

Genomic blacklist regions for C. elegans ce11

**Usage**

blacklist\_ce11

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

`blacklist_dm3`*Genomic blacklist regions for Drosophila dm3*

---

**Description**

Genomic blacklist regions for Drosophila dm3

**Usage**

```
blacklist_dm3
```

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

`blacklist_dm6`*Genomic blacklist regions for Drosophila dm6*

---

**Description**

Genomic blacklist regions for Drosophila dm6

**Usage**

```
blacklist_dm6
```

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

`blacklist_hg19`*Genomic blacklist regions for Human hg19*

---

**Description**

Genomic blacklist regions for Human hg19

**Usage**

`blacklist_hg19`

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

`blacklist_hg38`*Genomic blacklist regions for Human GRCh38*

---

**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](https://doi.org/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/> 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/>

doi: [10.1038/s4159801945839z](https://doi.org/10.1038/s4159801945839z)

---

blacklist\_mm10

*Genomic blacklist regions for Mouse mm10*

---

**Description**

Genomic blacklist regions for Mouse mm10

**Usage**

blacklist\_mm10

**Format**

A GRanges object

**Source**

<https://github.com/Boyle-Lab/Blacklist>

doi: [10.1038/s4159801945839z](https://doi.org/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,  
  outdir = 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,  
  effective.genome.size = 2.7e+09,  
  extsize = 200,  
  shift = -extsize/2,  
  additional.args = NULL,  
  name = "macs2",  
  cleanup = TRUE,  
  verbose = TRUE,  
  ...  
)
```

```

)

## S3 method for class 'Fragment'
CallPeaks(
  object,
  macs2.path = NULL,
  outdir = tempdir(),
  broad = FALSE,
  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,
  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, 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).

<code>idents</code>	List of identities to include if grouping cells (only valid if also setting the <code>group.by</code> parameter). If NULL, peaks will be called for all cell identities.
<code>macs2.path</code>	Path to MACS program. If NULL, try to find MACS automatically.
<code>broad</code>	Call broad peaks ( <code>--broad</code> parameter for MACS)
<code>outdir</code>	Path for output files
<code>combine.peaks</code>	Controls whether peak calls from different groups of cells are combined using <code>GenomicRanges::reduce</code> when calling peaks for different groups of cells ( <code>group.by</code> parameter). If FALSE, a list of <code>GRanges</code> 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.
<code>effective.genome.size</code>	Effective genome size parameter for MACS ( <code>-g</code> ). Default is the human effective genome size (2.7e9).
<code>extsize</code>	<code>extsize</code> parameter for MACS.
<code>shift</code>	<code>shift</code> parameter for MACS.
<code>additional.args</code>	Additional arguments passed to MACS. This should be a single character string
<code>name</code>	Name for output MACS files. This will also be placed in the <code>name</code> field in the <code>GRanges</code> output.
<code>cleanup</code>	Remove MACS output files
<code>verbose</code>	Display messages

### Details

See <https://macs3-project.github.io/MACS/> for MACS documentation.

If you call peaks using MACS2 please cite: doi: [10.1186/gb200899r137](https://doi.org/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 <a href="#">Fragment</a> object

**Details**

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

---

Cells<-	<i>Set and get cell barcode information for a Fragment object</i>
---------	---

---

**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	<i>Cells per group</i>
---------------	------------------------

---

**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	<i>The ChromatinAssay class</i>
----------------------	---------------------------------

---

**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	<i>Closest Feature</i>
----------------	------------------------

---

**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 <a href="#">StringToGRanges</a>

**Value**

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

**Examples**

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

---

ClusterClonotypes	<i>Find relationships between clonotypes</i>
-------------------	--

---

**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

---

CombineTracks	<i>Combine genome region plots</i>
---------------	------------------------------------

---

**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**

```
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)
```

### Arguments

conns	A dataframe containing co-accessible elements. This would usually be the output of <code>run_cicero</code> or <code>assemble_connections</code> . 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 <code>generate_ccans</code> . 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.

### 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	<i>Count fragments</i>
----------------	------------------------

---

**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**

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

---

CountsInRegion	<i>Counts in region</i>
----------------	-------------------------

---

**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 <a href="#">findOverlaps</a>

**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 <a href="#">ChromatinAssay</a> object
shift	How much each range should be shifted before coverage is computed. See <a href="#">coverage</a> in the <b>IRanges</b> package.
width	Specifies the length of the returned coverage vectors. See <a href="#">coverage</a> in the <b>IRanges</b> package.
weight	Assigns weight to each range in x. See <a href="#">coverage</a> in the <b>IRanges</b> package.
method	See <a href="#">coverage</a> in the <b>IRanges</b> 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	<i>Genome browser</i>
-----------------	-----------------------

---

**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 <a href="#">CoveragePlot</a>

**Value**

Returns a list of [ggplot](#) objects

---

CoveragePlot	<i>Plot Tn5 insertion frequency over a region</i>
--------------	---

---

**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",
  links = TRUE,
  tile = FALSE,
  tile.size = 100,
  tile.cells = 100,
  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,
  ...
)
```

**Arguments**

<code>object</code>	A Seurat object
<code>region</code>	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.
<code>features</code>	A vector of features present in another assay to plot alongside accessibility tracks (for example, gene names).
<code>assay</code>	Name of the assay to plot
<code>show.bulk</code>	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).

<code>expression.assay</code>	Name of the assay containing expression data to plot alongside accessibility tracks. Only needed if supplying features argument.
<code>expression.slot</code>	Name of slot to pull expression data from. Only needed if supplying the features argument.
<code>annotation</code>	Display gene annotations
<code>peaks</code>	Display peaks
<code>peaks.group.by</code>	Grouping variable to color peaks by. Must be a variable present in the feature metadata. If NULL, do not color peaks by any variable.
<code>ranges</code>	Additional genomic ranges to plot
<code>ranges.group.by</code>	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.
<code>ranges.title</code>	Y-axis title for ranges track. Only relevant if ranges parameter is set.
<code>links</code>	Display links
<code>tile</code>	Display per-cell fragment information in sliding windows.
<code>tile.size</code>	Size of the sliding window for per-cell fragment tile plot
<code>tile.cells</code>	Number of cells to display fragment information for in tile plot.
<code>heights</code>	Relative heights for each track (accessibility, gene annotations, peaks, links).
<code>group.by</code>	Name of one or more metadata columns to group (color) the cells by. Default is the current cell identities
<code>window</code>	Smoothing window size
<code>extend.upstream</code>	Number of bases to extend the region upstream.
<code>extend.downstream</code>	Number of bases to extend the region downstream.
<code>scale.factor</code>	Scaling factor for track height. If NULL (default), use the median group scaling factor determined by total number of fragments sequences in each group.
<code>ymin</code>	Minimum value for Y axis. If NULL (default) set to the lowest value among all the tracks.
<code>ymax</code>	Maximum value for Y axis. If NULL (default) set to the highest value among all the tracks.
<code>cells</code>	Which cells to plot. Default all cells
<code>idents</code>	Which identities to include in the plot. Default is all identities.
<code>sep</code>	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.
<code>max.downsample</code>	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

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

---

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

counts	Unnormalized data (raw counts)
data	Normalized data; if provided, do not pass counts
min.cells	Include features detected in at least this many cells. Will subset the counts matrix as well. To reintroduce excluded features, create a new object with a lower cutoff.
min.features	Include cells where at least this many features are detected.
max.cells	Include features detected in less than this many cells. Will subset the counts matrix as well. To reintroduce excluded features, create a new object with a higher cutoff. This can be useful for chromatin assays where certain artefactual loci accumulate reads in all cells. A percentage cutoff can also be set using 'q' followed by the percentage of cells, for example 'q90' will discard features detected in 90 percent of cells. If NULL (default), do not apply any maximum value.
ranges	A set of <a href="#">GRanges</a> corresponding to the rows of the input matrix
motifs	A Motif object (not required)
fragments	Path to a tabix-indexed fragments file for the data contained in the input matrix. If multiple fragment files are required, you can add additional <a href="#">Fragment</a> object to the assay after it is created using the <a href="#">CreateFragmentObject</a> and <a href="#">Fragments</a> functions. Alternatively, a list of <a href="#">Fragment</a> objects can be provided.
genome	A <a href="#">Seqinfo</a> 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	A set of <a href="#">GRanges</a> containing annotations for the genome used
bias	A Tn5 integration bias matrix
positionEnrichment	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).
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. Only used if ranges is NULL.

validate.fragments	Check that cells in the assay are present in the fragment file.
verbose	Display messages
...	Additional arguments passed to <a href="#">CreateFragmentObject</a>

---

CreateFragmentObject *Create a Fragment object*

---

## 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 <a href="#">ValidateCells</a>

## 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 <a href="#">PFMatrixList</a> or <a href="#">PWMMatrixList</a> object containing position weight/frequency matrices to use
genome	Any object compatible with the genome argument in <a href="#">matchMotifs</a>
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 <a href="#">matchMotifs</a>

## Details

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

## Value

Returns a sparse matrix

## Examples

```
## 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

```
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 <a href="#">PFMatrixList</a> .
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 <a href="#">PFMatrixList</a> is passed to pwm, it will pull the motif name from the <a href="#">PFMatrixList</a> .
positions	A <a href="#">GRangesList</a> object containing exact positions of each motif.
meta.data	A data.frame containing metadata

**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 <a href="#">Seurat</a> 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 <a href="#">cor</a>

**Value**

Returns a [ggplot](#) object

**Examples**

```
DepthCor(object = atac_small)
```

---

DownsampleFeatures      *Downsample Features*

---

### 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

<code>object</code>	A Seurat object
<code>assay</code>	Name of assay to use. Default is the active assay.
<code>n</code>	Number of features to retain (default 20000).
<code>verbose</code>	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**

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

---

 Extend

*Extend*


---

**Description**

Resize GenomicRanges upstream and or downstream. From <https://support.bioconductor.org/p/78652/>

**Usage**

```
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**

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

---

 FeatureMatrix

*Feature Matrix*


---

### 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 <a href="#">Fragment</a> objects.
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	<i>Filter cells from fragment file</i>
-------------	--

---

### 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

<code>fragments</code>	Path to a fragment file
<code>cells</code>	A vector of cells to keep
<code>outfile</code>	Name for output file
<code>buffer_length</code>	Size of buffer to be read from the fragment file. This must be longer than the longest line in the file.
<code>verbose</code>	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	<i>Find clonotypes</i>
----------------	------------------------

---

## 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

```
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 <a href="#">FindClusters</a>
k	Passed to k.param argument in <a href="#">FindNeighbors</a>
algorithm	Community detection algorithm to use. See <a href="#">FindClusters</a>

## Value

Returns a [Seurat](#) object

---

`FindMotifs`*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

<code>object</code>	A Seurat object
<code>features</code>	A vector of features to test for enrichments over background
<code>background</code>	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 <a href="#">RegionStats</a> function. If NULL, use all features in the assay.
<code>assay</code>	Which assay to use. Default is the active assay
<code>verbose</code>	Display messages
<code>...</code>	Arguments passed to <a href="#">MatchRegionStats</a> .

## 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  
)
```

---

findOverlaps-methods *Find overlapping ranges for ChromatinAssay objects*

---

### Description

The findOverlaps, countOverlaps methods are available for [ChromatinAssay](#) objects. This allows finding overlaps between genomic ranges and the ranges stored in the ChromatinAssay.

### Usage

```
## 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  
)
```

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

```

---

FoldChange

*Compute fold change between two groups of cells*

---

**Description**

Computes the fold change or log<sub>2</sub> fold change (if log=TRUE) in average counts between two groups of cells.



**Usage**

```
FoldChange(  
  object,  
  ident.1,  
  ident.2 = NULL,  
  group.by = NULL,  
  cutoff = 0.5,  
  assay = NULL,  
  verbose = TRUE  
)
```

**Arguments**

object	A Seurat object
ident.1	Identities of first group of cells to compare.
ident.2	Identities of second group of cells to compare. If NULL, compare cells in the first group to all other cells.
group.by	Grouping variable to use. If NULL, use the current cell identities.
cutoff	Mean count cutoff for classifying as "open". Only used for ordering results. Results will be ordered first by whether the average counts in ident.1 is greater than the cutoff value, then by fold change with respect to ident.2. This prevents very lowly detected peaks from being pushed to the top of the results due to high fold change values.
assay	Name of assay to use. If NULL, use the default assay.
verbose	Display messages

**Value**

Returns a data.frame

**Examples**

```
fc <- FoldChange(object = atac_small, ident.1 = 0)  
head(fc)
```

**Description**

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

**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 <a href="#">BSgenome</a> 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

<code>compute.expected</code>	Find the expected number of insertions at each position given the local DNA sequence context and the insertion bias of Tn5
<code>in.peaks</code>	Restrict motifs to those that fall in peaks
<code>verbose</code>	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**

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

**Arguments**

<code>object</code>	A Seurat object
<code>regions</code>	A GRanges object containing a set of genomic regions
<code>assay</code>	Name of assay to use
<code>...</code>	Additional arguments passed to <a href="#">CountsInRegion</a>

**Value**

Returns a numeric vector

**Examples**

```
FractionCountsInRegion(  
  object = atac_small,  
  assay = 'bins',  
  regions = blacklist_hg19  
)
```

---

Fragment-class	<i>The Fragment class</i>
----------------	---------------------------

---

### Description

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>
- 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.

---

FragmentHistogram	<i>Plot fragment length histogram</i>
-------------------	---------------------------------------

---

### Description

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

### Usage

```
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 fist 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**

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

---

Fragments

*Get the Fragment objects*


---

**Description**

Get the Fragment objects

**Usage**

```
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 <a href="#">Fragment</a> 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 <a href="#">CountFragments</a> function.
col.name	Name of column in metadata to store the FRiP information.
verbose	Display messages

**Value**

Returns a [Seurat](#) object

**Examples**

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

---

GeneActivity

*Create gene activity matrix*

---

**Description**

Compute counts per cell in gene body and promoter region.

**Usage**

```
GeneActivity(  
  object,  
  assay = NULL,  
  features = NULL,  
  extend.upstream = 2000,  
  extend.downstream = 0,  
  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
verbose	Display messages
...	Additional options passed to <a href="#">FeatureMatrix</a>

**Examples**

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

GenomeBinMatrix

*Genome bin matrix***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 <a href="#">Fragment</a> 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 <a href="#">seqlengths</a> on a <a href="#">BSgenome-class</a> 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

**Details**

This function bins the genome and calls [FeatureMatrix](#) to construct a bin x cell matrix.



**Value**

Returns a sparse matrix

**Examples**

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

---

GetCellsInRegion	<i>Get cells in a region</i>
------------------	------------------------------

---

**Description**

Extract cell names containing reads mapped within a given genomic region

**Usage**

```
GetCellsInRegion(tabix, region, sep = c("-", "-"), cells = NULL)
```

**Arguments**

tabix	Tabix object
region	A string giving the region to extract from the fragments file
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.
cells	Vector of cells to include in output. If NULL, include all cells

**Value**

Returns a list

**Examples**

```
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
GetCellsInRegion(tabix = fpath, region = "chr1-10245-762629")
```

---

GetFootprintData      *Get footprinting data*

---

### Description

Extract footprint data for a set of transcription factors or metafeatures. This function will pull accessibility data for a given feature (eg, 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      *Get Fragment object data*

---

### Description

Extract data from a [Fragment-class](#) object

### Usage

```
GetFragmentData(object, slot = "path")
```

### Arguments

object	A <a href="#">Fragment</a> 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

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

### Arguments

<code>ensdb</code>	An EnsDb object
<code>standard.chromosomes</code>	Keep only standard chromosomes
<code>biotypes</code>	Biotypes to keep
<code>verbose</code>	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 *n*th feature of the first vector will intersect the *n*th 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

```
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	<i>Get peaks linked to genes</i>
----------------	----------------------------------

---

**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	<i>Retrieve a motif matrix</i>
--------------	--------------------------------

---

**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", ...)
```

**Arguments**

object	A Seurat object
...	Arguments passed to other methods
slot	Information to pull from object (data, pwm, meta.data)
assay	Which assay to use. Default is the current active assay

**Value**

Returns a [Seurat](#) object

**Examples**

```
motif.obj <- Seurat::GetAssayData(  
  object = atac_small[['peaks']], slot = "motifs"  
)  
GetMotifData(object = motif.obj)  
GetMotifData(object = atac_small)
```

---

GetTSSPositions      *Find transcriptional start sites*

---

**Description**

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)
```

**Arguments**

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

---

granges-methods      *Access genomic ranges for ChromatinAssay objects*

---

## Description

Methods for accessing [GRanges](#) object information stored in a [ChromatinAssay](#) object.

## Usage

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

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

## Arguments

x	A <a href="#">ChromatinAssay</a> object
use.names	Whether the names on the genomic ranges should be propagated to the returned object.
use.mcols	Not supported for <a href="#">ChromatinAssay</a> 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

```
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)
```

---

IdentifyVariants      *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

```
## 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**

```

InsertionBias(object, ...)

## S3 method for class 'ChromatinAssay'
InsertionBias(object, genome, region = "chr1-1-249250621", verbose = TRUE, ...)

## S3 method for class 'Seurat'
InsertionBias(
  object,
  genome,
  assay = NULL,
  region = "chr1-1-249250621",
  verbose = TRUE,
  ...
)

```

**Arguments**

object	A Seurat or ChromatinAssay object
...	Additional arguments passed to <a href="#">StringToGRanges</a>
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**

```

## 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, disjoint, isDisjoint, disjointBins methods are available for [ChromatinAssay](#) objects.

## Usage

```
## 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 <a href="#">ChromatinAssay</a> object
...	Additional arguments
with.revmap	See <a href="#">inter-range-methods</a> in the <b>IRanges</b> packages
na.rm	Ignored
drop.empty.ranges	See <a href="#">?IRanges{inter-range-methods}</a>
start, end	See <a href="#">?IRanges{inter-range-methods}</a>

**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 <a href="#">findOverlaps</a>

**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 a NaN entry that could cause problems in downstream analyses.

**Usage**

```
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**

```
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.cells = 10,  
  method = "pearson",  
  genes.use = NULL,  
  n_sample = 200,  
  pvalue_cutoff = 0.05,  
  score_cutoff = 0.05,  
  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.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
verbose	Display messages

**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](https://doi.org/10.1016/j.cell.2020.09.056)

**Value**

Returns a Seurat object with the Links information set, with each recorded link being the correlation coefficient between the accessibility of the peak and expression of the gene.

---

LinkPlot

*Plot linked genomic elements*


---

**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 <a href="#">Seurat</a> object
region	A genomic region to plot
min.cutoff	Minimum absolute score for link to be plotted.

**Value**

Returns a [ggplot](#) object

---

Links	<i>Get or set links information</i>
-------	-------------------------------------

---

**Description**

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

**Usage**

```
Links(object, ...)

Links(object, ...) <- value

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

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

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

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

**Arguments**

object	A Seurat object
...	Arguments passed to other methods
value	A <a href="#">GRanges</a> object

**Examples**

```
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	<i>Get gene coordinates</i>
------------------	-----------------------------

---

**Description**

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

**Usage**

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

**Arguments**

object	A Seurat object
gene	Name of a gene to extract
assay	Name of assay to use

**Examples**

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

---

MatchRegionStats	<i>Match DNA sequence characteristics</i>
------------------	---

---

**Description**

Return a vector of 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**

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

**Arguments**

<code>meta.feature</code>	A dataframe containing DNA sequence information for features to choose from
<code>query.feature</code>	A dataframe containing DNA sequence information for features to match.
<code>features.match</code>	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.
<code>n</code>	Number of regions to select, with characteristics matching the query
<code>verbose</code>	Display messages
<code>...</code>	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**

```
metafeatures <- Seurat::GetAssayData(
  object = atac_small[['peaks']], slot = 'meta.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 PFMs, 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	<i>Plot DNA sequence motif</i>
-----------	--------------------------------

---

**Description**

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

**Usage**

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

**Arguments**

- |                        |   |
|------------------------|---|
| <code>object</code>    | A Seurat object   |
| <code>motifs</code>    | A list of motifs to plot                                  |
| <code>assay</code>     | Name of the assay to use                                  |
| <code>use.names</code> | Use motif names stored in the motif object                |
| <code>...</code>       | Additional parameters passed to <a href="#">ggseqlogo</a> |

**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

```
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 <a href="#">Motif</a> object

## Examples

```
Motifs(atac_small[["peaks"]])  
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

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

### Functions

- precede,ChromatinAssay,ANY-method: method for ChromatinAssay, ANY
- precede,ChromatinAssay,ChromatinAssay-method: method for ChromatinAssay, ChromatinAssay
- 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,ChromatinAssay,ChromatinAssay-method: method for ChromatinAssay, ChromatinAssay
- 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,ChromatinAssay,ChromatinAssay-method: method for ChromatinAssay, ChromatinAssay
- 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
- distance,ChromatinAssay,ChromatinAssay-method: method for ChromatinAssay, ChromatinAssay

- `distance,ANY,Seurat-method`: method for ANY, Seurat
- `distance,Seurat,ANY-method`: method for Seurat, ANY
- `distance,Seurat,Seurat-method`: method for Seurat, Seurat
- `distanceToNearest,ANY,ChromatinAssay-method`: method for ANY, ChromatinAssay
- `distanceToNearest,ChromatinAssay,ANY-method`: method for ChromatinAssay, ANY
- `distanceToNearest,ChromatinAssay,ChromatinAssay-method`: method for ChromatinAssay, ChromatinAssay
- `distanceToNearest,ANY,Seurat-method`: method for ANY, Seurat
- `distanceToNearest,Seurat,ANY-method`: method for Seurat, ANY
- `distanceToNearest,Seurat,Seurat-method`: method for Seurat, Seurat

### See Also

- [nearest-methods](#) in the **IRanges** package.
- [nearest-methods](#) in the **GenomicRanges** package
- [ChromatinAssay-class](#)

---

NucleosomeSignal      *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) * 10000,
  verbose = TRUE,
  ...
)
```

### Arguments

<code>object</code>	A Seurat object
<code>assay</code>	Name of assay to use. Only required if a fragment path is not provided. If NULL, use the active assay.
<code>n</code>	Number of lines to read from the fragment file. If NULL, read all lines. Default scales with the number of cells in the object.
<code>verbose</code>	Display messages
<code>...</code>	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**

```
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**

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

**Arguments**

object	A <a href="#">Seurat</a> object
region	A genomic region to plot
assay	Name of assay to use. If NULL, use the default assay.
peaks	A <a href="#">GRanges</a> 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**

<code>object</code>	A Seurat object
<code>features</code>	A vector of features to plot
<code>assay</code>	Name of assay to use
<code>group.by</code>	A grouping variable
<code>idents</code>	Set of identities to include in the plot

label	TRUE/FALSE value to control whether groups are labeled.
repel	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.ident	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>).

## Usage

```
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

```
## Not run:
data.dir <- system.file("extdata", "test_mgatk", package="Signac")
mgatk <- 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']],
```

```

    genome = BSgenome.Hsapiens.UCSC.hg19
  )

## 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

*Run chromVAR*


---

### 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

```

RunChromVAR(object, ...)

## 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

object	A Seurat object
...	Additional arguments passed to <a href="#">getBackgroundPeaks</a>
genome	A BSgenome object
motif.matrix	A peak x motif matrix. If NULL, pull the peak x motif matrix from a Motif object stored in the assay.

verbose            Display messages  
 assay             Name of assay to use  
 new.assay.name   Name of new assay used to store the chromVAR results. Default is "chromvar".

### Details

See the chromVAR documentation for more information: <https://greenleaflab.github.io/chromVAR/index.html>

See the chromVAR paper: <https://www.nature.com/articles/nmeth.4401>

### Value

Returns a [Seurat](#) object with a new assay

### Examples

```
## Not run:
library(BSgenome.Hsapiens.UCSC.hg19)
RunChromVAR(object = atac_small[["peaks"]], genome = BSgenome.Hsapiens.UCSC.hg19)

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

## End(Not run)
```

---

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,
```

```

    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

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

**Value**

Returns a [Seurat](#) object

**Examples**

```
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**

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

## Default S3 method:

```
RunTFIDF(
  object,
  assay = NULL,
  method = 1,
  scale.factor = 10000,
  verbose = TRUE,
  ...
)
```

## S3 method for class 'Assay'

```
RunTFIDF(
  object,
  assay = NULL,
  method = 1,
  scale.factor = 10000,
  verbose = TRUE,
  ...
)
```

## S3 method for class 'Seurat'

```
RunTFIDF(
  object,
  assay = NULL,
  method = 1,
  scale.factor = 10000,
```



```

    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: <ul style="list-style-type: none"> <li>• 1: The TF-IDF implementation used by Stuart &amp; Butler et al. 2019 (doi: <a href="https://doi.org/10.1101/460147">10.1101/460147</a>). This computes <math>\log(TF \times IDF)</math>.</li> <li>• 2: The TF-IDF implementation used by Cusanovich &amp; Hill et al. 2018 (doi: <a href="https://doi.org/10.1016/j.cell.2018.06.052">10.1016/j.cell.2018.06.052</a>). This computes <math>TF \times (\log(IDF))</math>.</li> <li>• 3: The log-TF method used by Andrew Hill. This computes <math>\log(TF) \times \log(IDF)</math>.</li> <li>• 4: The 10x Genomics method (no TF normalization). This computes <math>IDF</math>.</li> </ul>
scale.factor	Which scale factor to use. Default is 10000.
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](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[['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

```
## 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 <a href="#">ChromatinAssay</a> object
value	A <a href="#">Seqinfo</a> object or name of a UCSC genome to store in the <a href="#">ChromatinAssay</a>

### Functions

- `seqinfo<-`, `ChromatinAssay`-method: set method for `ChromatinAssay` objects
- `seqlevels`, `ChromatinAssay`-method: get method for `ChromatinAssay` objects
- `seqlevels<-`, `ChromatinAssay`-method: set method for `ChromatinAssay` objects
- `seqnames`, `ChromatinAssay`-method: get method for `ChromatinAssay` objects
- `seqnames<-`, `ChromatinAssay`-method: set method for `ChromatinAssay` objects

- `seqlengths`, `ChromatinAssay`-method: get method for `ChromatinAssay` objects
- `seqlengths<-`, `ChromatinAssay`-method: set method for `ChromatinAssay` objects
- `genome`, `ChromatinAssay`-method: get method for `ChromatinAssay` objects
- `genome<-`, `ChromatinAssay`-method: set 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
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- `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

```
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, ...)
```

**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**

```
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  
)
```

---

SplitFragments

*Split fragment file by cell identities*

---

**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**

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

**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 <a href="#">makeGRangesFromDataFrame</a>

**Value**

Returns a GRanges object

**Examples**

```
regions <- c('chr1-1-10', 'chr2-12-3121')
StringToGRanges(regions = regions)
```

---

subset.Motif	<i>Subset a Motif object</i>
--------------	------------------------------

---

### Description

Returns a subset of a [Motif-class](#) object.

### Usage

```
## 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

```
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***Subset matrix 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**

<code>mat</code>	A matrix
<code>min.rows</code>	Minimum number of non-zero elements for the row to be retained
<code>min.cols</code>	Minimum number of non-zero elements for the column to be retained
<code>max.row.val</code>	Maximum allowed value in a row for the row to be retained. If NULL, don't set any limit.
<code>max.col.val</code>	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	<i>Genome browser theme</i>
---------------	-----------------------------

---

**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	<i>Plot integration sites per cell</i>
----------	--

---

**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**

```
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: <https://www.encodeproject.org/data-standards/terms/>.

**Usage**

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

**Arguments**

<code>object</code>	A Seurat object
<code>tss.positions</code>	A GRanges object containing the TSS positions. If NULL, use the genomic annotations stored in the assay.
<code>n</code>	Number of TSS positions to use. This will select the first <code>_n_</code> TSSs from the set. If NULL, use all TSSs (slower).
<code>fast</code>	Just compute the TSS enrichment score, without storing the base-resolution matrix 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.
<code>assay</code>	Name of assay to use
<code>cells</code>	A vector of cells to include. If NULL (default), use all cells in the object
<code>process_n</code>	Number of regions to process at a time if using fast option.
<code>verbose</code>	Display messages

**Details**

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

**Value**

Returns a [Seurat](#) object

## Examples

```
## Not run:
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
Fragments(atac_small) <- CreateFragmentObject(
  path = fpath,
  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

```
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 <a href="#">TSSEnrichment</a>
group.by	Set of identities to group cells by
idents	Set of identities to include in the plot

## Value

Returns a [ggplot2](#) object

---

UnifyPeaks	<i>Unify genomic ranges</i>
------------	-----------------------------

---

**Description**

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

**Usage**

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

**Arguments**

<code>object.list</code>	A list of Seurat objects or ChromatinAssay objects
<code>mode</code>	Function to use when combining genomic ranges. Can be "reduce" (default) or "disjoin". See <a href="#">reduce</a> and <a href="#">disjoin</a> for more information on these functions.

**Value**

Returns a GRanges object

**Examples**

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

---

UpdatePath	<i>Update the file path for a Fragment object</i>
------------	---

---

**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**

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

**Arguments**

<code>object</code>	A <a href="#">Fragment</a> object
<code>new.path</code>	Path to the fragment file
<code>verbose</code>	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 <a href="#">Fragment</a> 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, ...)
```

**Arguments**

object	A <a href="#">Fragment</a> object
verbose	Display messages
...	Additional parameters passed to <a href="#">ValidateCells</a>

---

ValidateHash	<i>Validate hashes for Fragment object</i>
--------------	--

---

**Description**

Validate hashes for Fragment object

**Usage**

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

**Arguments**

object	A <a href="#">Fragment</a> object
verbose	Display messages

---

VariantPlot	<i>Plot strand concordance vs. VMR</i>
-------------	--

---

**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 <a href="#">IdentifyVariants</a>
min.cells	Minimum number of high-confidence cells detected with the variant to be displayed.
concordance.threshold	Strand concordance threshold
vmr.threshold	Mean-variance ratio threshold

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