

Package ‘SeuratObject’

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Description Defines S4 classes for single-cell genomic data and associated information, such as dimensionality reduction embeddings, nearest-neighbor graphs, and spatially-resolved coordinates. Provides data access methods and R-native hooks to ensure the Seurat object is familiar to other R users. See Satija R, Farrell J, Gennert D, et al (2015) <[doi:10.1038/nbt.3192](https://doi.org/10.1038/nbt.3192)>, Macosko E, Basu A, Satija R, et al (2015) <[doi:10.1016/j.cell.2015.05.002](https://doi.org/10.1016/j.cell.2015.05.002)>, and Stuart T, Butler A, et al (2019) <[doi:10.1016/j.cell.2019.05.031](https://doi.org/10.1016/j.cell.2019.05.031)> for more details.

URL <https://satijalab.org/seurat>,
<https://github.com/mojaveazure/seurat-object>

BugReports <https://github.com/mojaveazure/seurat-object/issues>

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R topics documented:

SeuratObject-package	3
AddMetaData	4
as.Graph	5
as.Neighbor	6
as.Seurat	7
as.sparse	7
Assay-class	8
Assay-methods	8
AssayData	11
Assays	12
AttachDeps	13
Cells	14
CellsByIdentities	15
CellsByImage	15
CheckGC	16
Command	16
CreateAssayObject	17
CreateDimReducObject	18
CreateSeuratObject	19
DefaultAssay	21
DimReduc-class	22
DimReduc-methods	23
Distances	25
Embeddings	25
FetchData	26
GetImage	27
GetTissueCoordinates	28
Graph-class	28
HVFInfo	29
Idents	31
Images	34
Index	34

Indices	35
IsGlobal	36
IsMatrixEmpty	36
JackStrawData-class	37
JackStrawData-methods	37
JS	38
Key	39
Loadings	40
LogSeuratCommand	41
Misc	42
Neighbor-class	43
Neighbor-methods	43
pbmc_small	44
Project	45
Radius	45
RenameAssays	46
RenameCells	46
RowMergeSparseMatrices	48
s4list	49
Seurat-class	50
seurat-class	50
Seurat-methods	52
SeuratCommand-class	57
SeuratCommand-methods	57
SpatialImage-class	58
SpatialImage-methods	59
Stdev	62
Tool	63
UpdateSeuratObject	64
Version	64
WhichCells	65
Index	67

SeuratObject-package *SeuratObject: Data Structures for Single Cell Data*

Description

Defines S4 classes for single-cell genomic data and associated information, such as dimensionality reduction embeddings, nearest-neighbor graphs, and spatially-resolved coordinates. Provides data access methods and R-native hooks to ensure the Seurat object is familiar to other R users. See Satija R, Farrell J, Gennert D, et al (2015) <doi:10.1038/nbt.3192>, Macosko E, Basu A, Satija R, et al (2015) <doi:10.1016/j.cell.2015.05.002>, and Stuart T, Butler A, et al (2019) <doi:10.1016/j.cell.2019.05.031> for more details.

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See Also

Useful links:

- <https://satijalab.org/seurat>
- <https://github.com/mojaveazure/seurat-object>
- Report bugs at <https://github.com/mojaveazure/seurat-object/issues>

AddMetaData

Add in metadata associated with either cells or features.

Description

Adds additional data to the object. Can be any piece of information associated with a cell (examples include read depth, alignment rate, experimental batch, or subpopulation identity) or feature (ENSG name, variance). To add cell level information, add to the Seurat object. If adding feature-level metadata, add to the Assay object (e.g. `object[["RNA"]]`)

Usage

```
AddMetaData(object, metadata, col.name = NULL)
```

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

```
AddMetaData(object, metadata, col.name = NULL)
```

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

```
AddMetaData(object, metadata, col.name = NULL)
```

Arguments

object	An object
metadata	A vector, list, or data.frame with metadata to add
col.name	A name for meta data if not a named list or data.frame

Value

object with metadata added

Examples

```
cluster_letters <- LETTERS[Idents(object = pbmc_small)]
names(cluster_letters) <- colnames(x = pbmc_small)
pbmc_small <- AddMetaData(
  object = pbmc_small,
  metadata = cluster_letters,
  col.name = 'letter.idents'
)
head(x = pbmc_small[[[]])
```

as.Graph

Coerce to a Graph Object

Description

Convert a [matrix](#) (or [Matrix](#)) to a [Graph](#) object

Usage

```
as.Graph(x, ...)

## S3 method for class 'Matrix'
as.Graph(x, ...)

## S3 method for class 'matrix'
as.Graph(x, ...)

## S3 method for class 'Neighbor'
as.Graph(x, weighted = TRUE, ...)
```

Arguments

x	The matrix to convert
...	Arguments passed to other methods (ignored for now)
weighted	If TRUE, fill entries in Graph matrix with value from the nn.dist slot of the Neighbor object

Value

A [Graph](#) object

Examples

```
# converting sparse matrix
mat <- Matrix::rsparsematrix(nrow = 10, ncol = 10, density = 0.1)
rownames(x = mat) <- paste0("feature_", 1:10)
colnames(x = mat) <- paste0("cell_", 1:10)
g <- as.Graph(x = mat)

# converting dense matrix
mat <- matrix(data = 1:16, nrow = 4)
rownames(x = mat) <- paste0("feature_", 1:4)
colnames(x = mat) <- paste0("cell_", 1:4)
g <- as.Graph(x = mat)
```

as.Neighbor

Coerce to a Neighbor Object

Description

Convert objects to [Neighbor](#) objects

Usage

```
as.Neighbor(x, ...)
```

```
## S3 method for class 'Graph'
as.Neighbor(x, ...)
```

Arguments

x An object to convert to [Neighbor](#)

... Arguments passed to other methods

Value

A [Neighbor](#) object

as.Seurat	<i>Coerce to a Seurat Object</i>
-----------	----------------------------------

Description

Convert objects to Seurat objects

Usage

```
as.Seurat(x, ...)
```

Arguments

x	An object to convert to class Seurat
...	Arguments passed to other methods

Value

A [Seurat](#) object generated from x

as.sparse	<i>Cast to Sparse</i>
-----------	-----------------------

Description

Convert dense objects to sparse representations

Usage

```
as.sparse(x, ...)
```

```
## S3 method for class 'data.frame'  
as.sparse(x, row.names = NULL, ...)
```

```
## S3 method for class 'Matrix'  
as.sparse(x, ...)
```

```
## S3 method for class 'matrix'  
as.sparse(x, ...)
```

Arguments

x	An object
...	Arguments passed to other methods
row.names	NULL or a character vector giving the row names for the data; missing values are not allowed

Value

A sparse representation of the input data

Assay-class	<i>The Assay Class</i>
-------------	------------------------

Description

The Assay object is the basic unit of Seurat; each Assay stores raw, normalized, and scaled data as well as cluster information, variable features, and any other assay-specific metadata. Assays should contain single cell expression data such as RNA-seq, protein, or imputed expression data.

Slots

counts Unnormalized data such as raw counts or TPMs

data Normalized expression data

scale.data Scaled expression data

key Key for the Assay

assay.orig Original assay that this assay is based off of. Used to track assay provenance

var.features Vector of features exhibiting high variance across single cells

meta.features Feature-level metadata

misc Utility slot for storing additional data associated with the assay

See Also

[Assay-methods](#)

Assay-methods	<i>Assay Methods</i>
---------------	----------------------

Description

Methods for [Assay](#) objects for generics defined in other packages

Usage

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

## S3 method for class 'Assay'
x[[i, ..., drop = FALSE]]

## S3 method for class 'Assay'
dim(x)

## S3 method for class 'Assay'
dimnames(x)

## S3 method for class 'Assay'
head(x, n = 10L, ...)

## S3 method for class 'Assay'
merge(x = NULL, y = NULL, add.cell.ids = NULL, merge.data = TRUE, ...)

## S3 method for class 'Assay'
subset(x, cells = NULL, features = NULL, ...)

## S3 method for class 'Assay'
tail(x, n = 10L, ...)

## S4 replacement method for signature 'Assay'
x[[i, j, ...]] <- value

## S4 method for signature 'Assay'
colMeans(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Assay'
colSums(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Assay'
rowMeans(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Assay'
rowSums(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Assay'
show(object)
```

Arguments

x, object	An Assay object
i, features	For <code>[</code> : metadata names; for all other methods, feature names or indices
j, cells	Cell names or indices

...	Arguments passed to other methods
drop	See drop
n	an integer vector of length up to <code>dim(x)</code> (or 1, for non-dimensional objects). Values specify the indices to be selected in the corresponding dimension (or along the length) of the object. A positive value of <code>n[i]</code> includes the first/last <code>n[i]</code> indices in that dimension, while a negative value excludes the last/first <code>abs(n[i])</code> , including all remaining indices. NA or non-specified values (when <code>length(n) < length(dim(x))</code>) select all indices in that dimension. Must contain at least one non-missing value.
y	A vector or list of one or more objects to merge
<code>add.cell.ids</code>	A character vector of length <code>x = c(x, y)</code> ; appends the corresponding values to the start of each objects' cell names
<code>merge.data</code>	Merge the data slots instead of just merging the counts (which requires renormalization); this is recommended if the same normalization approach was applied to all objects
value	Additional metadata to add
<code>na.rm</code>	logical. Should missing values (including NaN) be omitted from the calculations?
<code>dims</code>	completely ignored by the <code>Matrix</code> methods.
<code>slot</code>	Name of assay expression matrix to calculate column/row means/sums on

Value

`[`: The data slot for features `i` and cells `j`
`[[`: The feature-level metadata for `i`
`dim`: The number of features (`nrow`) and cells (`ncol`)
`dimnames`: Feature (row) and cell (column) names
`head`: The first `n` rows of feature-level metadata
`merge`: Merged object
`subset`: A subsetted Assay
`tail`: The last `n` rows of feature-level metadata
`[[<-`: `x` with metadata value added as `i`
`colMeans`: The column (cell-wise) means of `slot`
`colSums`: The column (cell-wise) sums of `slot`
`rowMeans`: The row (feature-wise) means of `slot`
`rowSums`: The row (feature-wise) sums of `slot`
`show`: Prints summary to `stdout` and invisibly returns `NULL`

Functions

- `[.Assay`: Get expression data from an Assay
- `[[.Assay`: Get feature-level metadata
- `dim.Assay`: Number of cells and features for an Assay
- `dimnames.Assay`: Cell- and feature-names for an Assay
- `head.Assay`: Get the first rows of feature-level metadata
- `merge.Assay`: Merge Assay objects
- `subset.Assay`: Subset an Assay
- `tail.Assay`: Get the last rows of feature-level metadata
- `[[<-`, Assay-method: Add feature-level metadata
- `colMeans`, Assay-method: Calculate [colMeans](#) on an Assay
- `colSums`, Assay-method: Calculate [colSums](#) on an Assay
- `rowMeans`, Assay-method: Calculate [rowMeans](#) on an Assay
- `rowSums`, Assay-method: Calculate [rowSums](#) on an Assay
- `show`, Assay-method: Overview of an Assay object

 AssayData

Get and Set Assay Data

Description

General accessor and setter functions for [Assay](#) objects. `GetAssayData` can be used to pull information from any of the expression matrices (eg. “counts”, “data”, or “scale.data”). `SetAssayData` can be used to replace one of these expression matrices

Usage

```
GetAssayData(object, slot, ...)
```

```
SetAssayData(object, slot, new.data, ...)
```

```
## S3 method for class 'Seurat'
GetAssayData(object, slot = "data", assay = NULL, ...)
```

```
## S3 method for class 'Seurat'
SetAssayData(object, slot = "data", new.data, assay = NULL, ...)
```

```
## S3 method for class 'Assay'
GetAssayData(object, slot = c("data", "scale.data", "counts"), ...)
```

```
## S3 method for class 'Assay'
SetAssayData(object, slot = c("data", "scale.data", "counts"), new.data, ...)
```

Arguments

object	An object
slot	Specific assay data to get or set
...	Arguments passed to other methods
new.data	New assay data to add
assay	Specific assay to get data from or set data for; defaults to the default assay

Value

GetAssayData: returns the specified assay data

SetAssayData: object with the assay data set

Examples

```
# Get assay data from the default assay in a Seurat object
GetAssayData(object = pbmc_small, slot = "data")[1:5,1:5]

# Set an Assay slot through the Seurat object
count.data <- GetAssayData(object = pbmc_small[["RNA"]], slot = "counts")
count.data <- as.matrix(x = count.data + 1)
new.seurat.object <- SetAssayData(
  object = pbmc_small,
  slot = "counts",
  new.data = count.data,
  assay = "RNA"
)

# Get the data directly from an Assay object
GetAssayData(pbmc_small[["RNA"]], slot = "data")[1:5,1:5]

# Set an Assay slot directly
count.data <- GetAssayData(pbmc_small[["RNA"]], slot = "counts")
count.data <- as.matrix(x = count.data + 1)
new.assay <- SetAssayData(pbmc_small[["RNA"]], slot = "counts", new.data = count.data)
```

 Assays

Query Specific Object Types

Description

List the names of [Assay](#), [DimReduc](#), [Graph](#), [Neighbor](#) objects

Usage

```
Assays(object, slot = NULL)

Graphs(object, slot = NULL)

Neighbors(object, slot = NULL)

Reductions(object, slot = NULL)
```

Arguments

object	A Seurat object
slot	Name of component object to return

Value

If slot is NULL, the names of all component objects in this Seurat object. Otherwise, the specific object specified

Examples

```
Assays(object = pbmc_small)

Graphs(pbmc_small)

Reductions(object = pbmc_small)
```

AttachDeps

Attach Required Packages

Description

Helper function to attach required packages. Detects if a package is already attached and if so, skips it. Should be called in [.onAttach](#)

Usage

```
AttachDeps(deps)
```

Arguments

deps	A character vector of packages to attach
------	--

Value

Invisibly returns NULL

Examples

```
# Use in your .onAttach hook
if (FALSE) {
  .onAttach <- function(libname, pkgname) {
    AttachDeps(c("SeuratObject", "rlang"))
  }
}
```

Cells

Get cells present in an object

Description

Get cells present in an object

Usage

```
Cells(x)
```

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

```
Cells(x)
```

```
## S3 method for class 'DimReduc'
```

```
Cells(x)
```

```
## S3 method for class 'Neighbor'
```

```
Cells(x)
```

Arguments

```
x          An object
```

Value

A vector of cell names

Examples

```
Cells(x = pbmc_small)
```

CellsByIdentities *Get cell names grouped by identity class*

Description

Get cell names grouped by identity class

Usage

```
CellsByIdentities(object, ids = NULL, cells = NULL, return.null = FALSE)
```

Arguments

object	A Seurat object
ids	A vector of identity class levels to limit resulting list to; defaults to all identity class levels
cells	A vector of cells to grouping to
return.null	If no cells are request, return a NULL; by default, throws an error

Value

A named list where names are identity classes and values are vectors of cells belonging to that class

Examples

```
CellsByIdentities(object = pbmc_small)
```

CellsByImage *Get a vector of cell names associated with an image (or set of images)*

Description

Get a vector of cell names associated with an image (or set of images)

Usage

```
CellsByImage(object, images = NULL, unlist = FALSE)
```

Arguments

object	Seurat object
images	Vector of image names
unlist	Return as a single vector of cell names as opposed to a list, named by image name.

Value

A vector of cell names

Examples

```
## Not run:
CellsByImage(object = object, images = "slice1")

## End(Not run)
```

CheckGC

Conditional Garbage Collection

Description

Call gc only when desired

Usage

```
CheckGC(option = "SeuratObject.memsafe")
```

Arguments

option ...

Value

Invisibly returns NULL

Command

Get SeuratCommands

Description

Pull information on previously run commands in the Seurat object.

Usage

```
Command(object, ...)
```

```
## S3 method for class 'Seurat'
Command(object, command = NULL, value = NULL, ...)
```


Arguments

object	An object
...	Arguments passed to other methods
command	Name of the command to pull, pass NULL to get the names of all commands run
value	Name of the parameter to pull the value for

Value

Either a SeuratCommand object or the requested parameter value

CreateAssayObject	<i>Create an Assay object</i>
-------------------	-------------------------------

Description

Create an Assay object from a feature (e.g. gene) expression matrix. The expected format of the input matrix is features x cells.

Usage

```
CreateAssayObject(counts, data, min.cells = 0, min.features = 0, ...)
```

Arguments

counts	Unnormalized data such as raw counts or TPMs
data	Prenormalized 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.
...	Arguments passed to as.sparse

Details

Non-unique cell or feature names are not allowed. Please make unique before calling this function.

Value

A [Assay](#) object

Examples

```
## Not run:
pbmc_raw <- read.table(
  file = system.file('extdata', 'pbmc_raw.txt', package = 'Seurat'),
  as.is = TRUE
)
pbmc_rna <- CreateAssayObject(counts = pbmc_raw)
pbmc_rna

## End(Not run)
```

CreateDimReducObject *Create a DimReduc object*

Description

Create a DimReduc object

Usage

```
CreateDimReducObject(
  embeddings = new(Class = "matrix"),
  loadings = new(Class = "matrix"),
  projected = new(Class = "matrix"),
  assay = NULL,
  stdev = numeric(),
  key = NULL,
  global = FALSE,
  jackstraw = NULL,
  misc = list()
)
```

Arguments

embeddings	A matrix with the cell embeddings
loadings	A matrix with the feature loadings
projected	A matrix with the projected feature loadings
assay	Assay used to calculate this dimensional reduction
stdev	Standard deviation (if applicable) for the dimensional reduction
key	A character string to facilitate looking up features from a specific DimReduc
global	Specify this as a global reduction (useful for visualizations)
jackstraw	Results from the JackStraw function
misc	list for the user to store any additional information associated with the dimensional reduction

Value

A `DimReduc` object

Examples

```
data <- GetAssayData(pbmc_small[["RNA"]], slot = "scale.data")
pcs <- prcomp(x = data)
pca.dr <- CreateDimReducObject(
  embeddings = pcs$rotation,
  loadings = pcs$x,
  stdev = pcs$sdev,
  key = "PC",
  assay = "RNA"
)
```

CreateSeuratObject *Create a Seurat object*

Description

Create a Seurat object from raw data

Usage

```
CreateSeuratObject(
  counts,
  project = "CreateSeuratObject",
  assay = "RNA",
  names.field = 1,
  names.delim = "_",
  meta.data = NULL,
  ...
)
```

Default S3 method:

```
CreateSeuratObject(
  counts,
  project = "SeuratProject",
  assay = "RNA",
  names.field = 1,
  names.delim = "_",
  meta.data = NULL,
  min.cells = 0,
  min.features = 0,
  row.names = NULL,
  ...
)
```

```

)

## S3 method for class 'Assay'
CreateSeuratObject(
  counts,
  project = "SeuratProject",
  assay = "RNA",
  names.field = 1,
  names.delim = "_",
  meta.data = NULL,
  ...
)

```

Arguments

<code>counts</code>	Either a matrix -like object with unnormalized data with cells as columns and features as rows or an Assay -derived object
<code>project</code>	Project name for the Seurat object
<code>assay</code>	Name of the initial assay
<code>names.field</code>	For the initial identity class for each cell, choose this field from the cell's name. E.g. If your cells are named as <code>BARCODE_CLUSTER_CELLTYPE</code> in the input matrix, set <code>names.field</code> to 3 to set the initial identities to <code>CELLTYPE</code> .
<code>names.delim</code>	For the initial identity class for each cell, choose this delimiter from the cell's column name. E.g. If your cells are named as <code>BARCODE-CLUSTER-CELLTYPE</code> , set this to <code>"-"</code> to separate the cell name into its component parts for picking the relevant field.
<code>meta.data</code>	Additional cell-level metadata to add to the Seurat object. Should be a data.frame where the rows are cell names and the columns are additional metadata fields. Row names in the metadata need to match the column names of the counts matrix.
<code>...</code>	Arguments passed to other methods
<code>min.cells</code>	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.
<code>min.features</code>	Include cells where at least this many features are detected.
<code>row.names</code>	When <code>counts</code> is a <code>data.frame</code> or <code>data.frame</code> -derived object: an optional vector of feature names to be used

Value

A [Seurat](#) object

Note

In previous versions (<3.0), this function also accepted a parameter to set the expression threshold for a 'detected' feature (gene). This functionality has been removed to simplify the initialization process/assumptions. If you would still like to impose this threshold for your particular dataset, simply filter the input expression matrix before calling this function.

Examples

```
## Not run:
pbmc_raw <- read.table(
  file = system.file('extdata', 'pbmc_raw.txt', package = 'Seurat'),
  as.is = TRUE
)
pbmc_small <- CreateSeuratObject(counts = pbmc_raw)
pbmc_small

## End(Not run)
```

DefaultAssay

Default Assay

Description

Get and set the default assay

Usage

```
DefaultAssay(object, ...)

DefaultAssay(object, ...) <- value

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

## S3 replacement method for class 'Assay'
DefaultAssay(object, ...) <- value

## S3 method for class 'SeuratCommand'
DefaultAssay(object, ...)

## S3 method for class 'DimReduc'
DefaultAssay(object, ...)

## S3 replacement method for class 'DimReduc'
DefaultAssay(object, ...) <- value

## S3 method for class 'Graph'
DefaultAssay(object, ...)

## S3 replacement method for class 'Graph'
DefaultAssay(object, ...) <- value

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

```
DefaultAssay(object, ...)

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

Arguments

object	An object
...	Arguments passed to other methods
value	Name of assay to set as default

Value

DefaultAssay: The name of the default assay
 DefaultAssay<-: An object with the default assay updated

Examples

```
# Get current default assay
DefaultAssay(object = pbmc_small)

# Create dummy new assay to demo switching default assays
new.assay <- pbmc_small[["RNA"]]
Key(object = new.assay) <- "RNA2_"
pbmc_small[["RNA2"]] <- new.assay
# switch default assay to RNA2
DefaultAssay(object = pbmc_small) <- "RNA2"
DefaultAssay(object = pbmc_small)
```

 DimReduc-class

The Dimensional Reduction Class

Description

The DimReduc object stores a dimensionality reduction taken out in Seurat; each DimReduc consists of a cell embeddings matrix, a feature loadings matrix, and a projected feature loadings matrix.

Slots

cell.embeddings	Cell embeddings matrix (required)
feature.loadings	Feature loadings matrix (optional)
feature.loadings.projected	Projected feature loadings matrix (optional)
assay.used	Name of assay used to generate DimReduc object
global	Is this DimReduc global/persistent? If so, it will not be removed when removing its associated assay

stdev A vector of standard deviations
 key Key for the DimReduc, must be alphanumeric characters followed by an underscore
 jackstraw A [JackStrawData-class](#) object associated with this DimReduc
 misc Utility slot for storing additional data associated with the DimReduc (e.g. the total variance of the PCA)

 DimReduc-methods

 DimReduc *Methods*

Description

Methods for [DimReduc](#) objects for generics defined in other packages

Usage

```

## S3 method for class 'DimReduc'
x[i, j, drop = FALSE, ...]

## S3 method for class 'DimReduc'
x[[i, j, drop = FALSE, ...]]

## S3 method for class 'DimReduc'
dim(x)

## S3 method for class 'DimReduc'
dimnames(x)

## S3 method for class 'DimReduc'
length(x)

## S3 method for class 'DimReduc'
merge(x = NULL, y = NULL, add.cell.ids = NULL, ...)

## S3 method for class 'DimReduc'
names(x)

## S3 method for class 'DimReduc'
print(x, dims = 1:5, nfeatures = 20, projected = FALSE, ...)

## S3 method for class 'DimReduc'
subset(x, cells = NULL, features = NULL, ...)

## S4 method for signature 'DimReduc'
show(object)

```

Arguments

<code>x</code> , object	A <code>DimReduc</code> object
<code>i</code>	For <code>[]</code> : feature names or indices; for <code>[[[]]</code> : cell names or indices
<code>j</code>	Dimensions to pull for
<code>drop</code>	See <code>drop</code>
<code>...</code>	Arguments passed to other methods
<code>y</code>	A vector or list of one or more objects to merge
<code>add.cell.ids</code>	A character vector of length(<code>x = c(x,y)</code>); appends the corresponding values to the start of each objects' cell names
<code>dims</code>	Number of dimensions to display
<code>nfeatures</code>	Number of genes to display
<code>projected</code>	Use projected slot
<code>cells, features</code>	Cells and features to keep during the subset

Value

`[]`: Feature loadings for features `i` and dimensions `j`
`[[[]]`: Cell embeddings for cells `i` and dimensions `j`
`dim`: The number of cells (`nrow`) and dimensions (`ncol`)
`dimnames`: The cell (row) and dimension (column) names
`length`: The number of dimensions
`names`: The names for the dimensions (eg. "PC_1")
`print`: Displays set of features defining the components and invisibly returns `x`
`subset`: `x` for cells `cells` and features `features`
`show`: Prints summary to `stdout` and invisibly returns `NULL`

Functions

- `[]`.`DimReduc`: Pull feature loadings
- `[[[]]`.`DimReduc`: Pull cell embeddings
- `dim`.`DimReduc`: The number of cells and dimensions for a `DimReduc`
- `dimnames`.`DimReduc`: The cell and dimension names for a `DimReduc` object
- `length`.`DimReduc`: The number of dimensions for a `DimReduc` object
- `merge`.`DimReduc`: Merge two or more `DimReduc` objects together
- `names`.`DimReduc`: The dimension names for a `DimReduc` object
- `print`.`DimReduc`: Prints a set of features that most strongly define a set of components; **note**: requires feature loadings to be present in order to work
- `subset`.`DimReduc`: Subset a `DimReduc` object
- `show`,`DimReduc`-method: Show basic summary of a `DimReduc` object

See Also[cat](#)

Distances*Get the Neighbor nearest neighbors distance matrix*

Description

Get the Neighbor nearest neighbors distance matrix

Usage

```
Distances(object, ...)  
  
## S3 method for class 'Neighbor'  
Distances(object, ...)
```

Arguments

object	An object
...	Arguments passed to other methods

Value

The distance matrix

Embeddings*Get Cell Embeddings*

Description

Get Cell Embeddings

Usage

```
Embeddings(object, ...)  
  
## S3 method for class 'DimReduc'  
Embeddings(object, ...)  
  
## S3 method for class 'Seurat'  
Embeddings(object, reduction = "pca", ...)
```

Arguments

object	An object
...	Arguments passed to other methods
reduction	Name of reduction to pull cell embeddings for

Value

The embeddings matrix

Examples

```
# Get the embeddings directly from a DimReduc object
Embeddings(object = pbmc_small[["pca"]])[1:5, 1:5]

# Get the embeddings from a specific DimReduc in a Seurat object
Embeddings(object = pbmc_small, reduction = "pca")[1:5, 1:5]
```

FetchData

Access cellular data

Description

Retrieves data (feature expression, PCA scores, metrics, etc.) for a set of cells in a Seurat object

Usage

```
FetchData(object, vars, cells = NULL, slot = "data")
```

Arguments

object	Seurat object
vars	List of all variables to fetch, use keyword "ident" to pull identity classes
cells	Cells to collect data for (default is all cells)
slot	Slot to pull feature data for

Value

A data frame with cells as rows and cellular data as columns

Examples

```
pc1 <- FetchData(object = pbmc_small, vars = 'PC_1')
head(x = pc1)
head(x = FetchData(object = pbmc_small, vars = c('groups', 'ident')))
```

GetImage

Get image data

Description

Get image data

Usage

```
GetImage(object, mode = c("grob", "raster", "plotly", "raw"), ...)
```

```
## S3 method for class 'Seurat'  
GetImage(  
  object,  
  mode = c("grob", "raster", "plotly", "raw"),  
  image = NULL,  
  ...  
)
```

Arguments

object	An object
mode	How to return the image; should accept one of “grob”, “raster”, “plotly”, or “raw”
...	Arguments passed to other methods
image	Name of SpatialImage object to pull image data for; if NULL, will attempt to select an image automatically

Value

Image data, varying depending on the value of mode:

“**grob**” An object representing image data inheriting from grob objects (eg. rastergrob)

“**raster**” An object of class raster

“**plotly**” A list with image data suitable for Plotly rendering, see [plotly::layout](#) for more details

“**raw**” The raw image data as stored in the object

See Also

[layout](#)

GetTissueCoordinates *Get tissue coordinates*

Description

Get tissue coordinates

Usage

```
GetTissueCoordinates(object, ...)

## S3 method for class 'Seurat'
GetTissueCoordinates(object, image = NULL, ...)
```

Arguments

object	An object
...	Arguments passed to other methods
image	Name of SpatialImage object to get coordinates for; if NULL, will attempt to select an image automatically

Value

A data frame with tissue coordinates

Graph-class *The Graph Class*

Description

The Graph class inherits from [dgMatrix](#). We do this to enable future expandability of graphs.

Slots

assay.used Optional name of assay used to generate Graph object

See Also

[dgMatrix-class](#)

HVInfo	<i>Highly Variable Features</i>
--------	---------------------------------

Description

Get and set variable feature information for an [Assay](#) object. HVInfo and VariableFeatures utilize generally variable features, while SVInfo and SpatiallyVariableFeatures are restricted to spatially variable features

Usage

```
HVInfo(object, selection.method, status = FALSE, ...)
```

```
VariableFeatures(object, selection.method = NULL, ...)
```

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

```
SVInfo(object, selection.method, status, ...)
```

```
SpatiallyVariableFeatures(object, selection.method, ...)
```

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

```
HVInfo(object, selection.method = NULL, status = FALSE, assay = NULL, ...)
```

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

```
VariableFeatures(object, selection.method = NULL, assay = NULL, ...)
```

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

```
VariableFeatures(object, assay = NULL, ...) <- value
```

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

```
SVInfo(
  object,
  selection.method = c("markvariogram", "moransi"),
  status = FALSE,
  assay = NULL,
  ...
)
```

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

```
SpatiallyVariableFeatures(
  object,
  selection.method = "markvariogram",
  assay = NULL,
  decreasing = TRUE,
  ...
)
```

```

## S3 method for class 'Assay'
HVFInfo(object, selection.method, status = FALSE, ...)

## S3 method for class 'Assay'
SpatiallyVariableFeatures(
  object,
  selection.method = "markvariogram",
  decreasing = TRUE,
  ...
)

## S3 method for class 'Assay'
SVFInfo(
  object,
  selection.method = c("markvariogram", "moransi"),
  status = FALSE,
  ...
)

## S3 method for class 'Assay'
VariableFeatures(object, selection.method = NULL, ...)

## S3 replacement method for class 'Assay'
VariableFeatures(object, ...) <- value

```

Arguments

object	An object
selection.method	Which method to pull. For HVFInfo and VariableFeatures, choose one from one of the following: <ul style="list-style-type: none"> • “vst” • “sctransform” or “sct” • “mean.var.plot”, “dispersion”, “mvp”, or “disp” For SVFInfo and SpatiallyVariableFeatures, choose from: <ul style="list-style-type: none"> • “markvariogram” • “moransi”
status	Add variable status to the resulting data frame
...	Arguments passed to other methods
value	A character vector of variable features
assay	Name of assay to pull highly variable feature information for
decreasing	Return features in decreasing order (most spatially variable first).

Value

HVFInfo: A data frame with feature means, dispersion, and scaled dispersion

VariableFeatures: a vector of the variable features

SVFInfo: a data frame with the spatially variable features

SpatiallyVariableFeatures: a character vector of the spatially variable features

Examples

```
# Get the HVF info from a specific Assay in a Seurat object
HVFInfo(object = pbmc_small, assay = "RNA")[1:5, ]

# Get the HVF info directly from an Assay object
HVFInfo(pbmc_small[["RNA"]], selection.method = 'vst')[1:5, ]
```

 Idents

Get, set, and manipulate an object's identity classes

Description

Get, set, and manipulate an object's identity classes

Usage

```
Idents(object, ...)

Idents(object, ...) <- value

RenameIdents(object, ...)

ReorderIdent(object, var, ...)

SetIdent(object, ...)

StashIdent(object, save.name, ...)

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

## S3 replacement method for class 'Seurat'
Idents(object, cells = NULL, drop = FALSE, ...) <- value

## S3 method for class 'Seurat'
ReorderIdent(
  object,
  var,
```

```

    reverse = FALSE,
    afxn = mean,
    reorder.numeric = FALSE,
    ...
)

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

## S3 method for class 'Seurat'
SetIdent(object, cells = NULL, value, ...)

## S3 method for class 'Seurat'
StashIdent(object, save.name = "orig.ident", ...)

## S3 method for class 'Seurat'
droplevels(x, ...)

## S3 method for class 'Seurat'
levels(x)

## S3 replacement method for class 'Seurat'
levels(x) <- value

```

Arguments

...	Arguments passed to other methods; for <code>RenameIdents</code> : named arguments as <code>old.ident = new.ident</code> ; for <code>ReorderIdent</code> : arguments passed on to FetchData
value	The name of the identities to pull from object metadata or the identities themselves
var	Feature or variable to order on
save.name	Store current identity information under this name
cells	Set cell identities for specific cells
drop	Drop unused levels
reverse	Reverse ordering
afxn	Function to evaluate each identity class based on; default is mean
reorder.numeric	Rename all identity classes to be increasing numbers starting from 1 (default is FALSE)
x, object	An object

Value

Idents: The cell identities

Idents<-: object with the cell identities changed

RenameIdents: An object with selected identity classes renamed

ReorderIdent: An object with
 SetIdent: An object with new identity classes set
 StashIdent: An object with the identities stashed

Examples

```
# Get cell identity classes
Idents(pbmc_small)

# Set cell identity classes
# Can be used to set identities for specific cells to a new level
Idents(pbmc_small, cells = 1:4) <- 'a'
head(Idents(pbmc_small))

# Can also set idents from a value in object metadata
colnames(pbmc_small[[[]]])
Idents(pbmc_small) <- 'RNA_snn_res.1'
levels(pbmc_small)

# Rename cell identity classes
# Can provide an arbitrary amount of idents to rename
levels(pbmc_small)
pbmc_small <- RenameIdents(pbmc_small, '0' = 'A', '2' = 'C')
levels(pbmc_small)

## Not run:
head(Idents(pbmc_small))
pbmc_small <- ReorderIdent(pbmc_small, var = 'PC_1')
head(Idents(pbmc_small))

## End(Not run)

# Set cell identity classes using SetIdent
cells.use <- WhichCells(pbmc_small, idents = '1')
pbmc_small <- SetIdent(pbmc_small, cells = cells.use, value = 'B')

head(pbmc_small[[[]]])
pbmc_small <- StashIdent(pbmc_small, save.name = 'idents')
head(pbmc_small[[[]]])

# Get the levels of identity classes of a Seurat object
levels(x = pbmc_small)

# Reorder identity classes
levels(x = pbmc_small)
levels(x = pbmc_small) <- c('C', 'A', 'B')
levels(x = pbmc_small)
```

Images	<i>Pull spatial image names</i>
--------	---------------------------------

Description

List the names of SpatialImage objects present in a Seurat object. If assay is provided, limits search to images associated with that assay

Usage

```
Images(object, assay = NULL)
```

Arguments

object	A Seurat object
assay	Name of assay to limit search to

Value

A list of image names

Examples

```
## Not run:
Images(object)

## End(Not run)
```

Index	<i>Get Neighbor algorithm index</i>
-------	-------------------------------------

Description

Get Neighbor algorithm index

Usage

```
Index(object, ...)

Index(object, ...) <- value

## S3 method for class 'Neighbor'
Index(object, ...)

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

Arguments

object	An object
...	Arguments passed to other methods;
value	The index to store

Value

Returns the value in the alg.idx slot of the Neighbor object

Idents<-: A Neighbor object with the index stored

 Indices

Get Neighbor nearest neighbor index matrices

Description

Get Neighbor nearest neighbor index matrices

Usage

```
Indices(object, ...)
```

```
## S3 method for class 'Neighbor'
Indices(object, ...)
```

Arguments

object	An object
...	Arguments passed to other methods;

Value

A matrix with the nearest neighbor indices

IsGlobal	<i>Is an object global/persistent?</i>
----------	--

Description

Typically, when removing Assay objects from an Seurat object, all associated objects (eg. DimReduc, Graph, and SeuratCommand objects) are removed as well. If an associated object is marked as global/persistent, the associated object will remain even if its original assay was deleted

Usage

```
IsGlobal(object, ...)

## Default S3 method:
IsGlobal(object, ...)

## S3 method for class 'DimReduc'
IsGlobal(object, ...)
```

Arguments

object	An object
...	Arguments passed to other methods

Value

TRUE if the object is global/persistent otherwise FALSE

Examples

```
IsGlobal(pbmc_small[['pca']])
```

IsMatrixEmpty	<i>Check if a matrix is empty</i>
---------------	-----------------------------------

Description

Takes a matrix and asks if it's empty (either 0x0 or 1x1 with a value of NA)

Usage

```
IsMatrixEmpty(x)
```

Arguments

x	A matrix
---	----------

Value

Whether or not x is empty

Examples

```
IsMatrixEmpty(new("matrix"))
IsMatrixEmpty(matrix())
IsMatrixEmpty(matrix(1:3))
```

JackStrawData-class *The JackStrawData Class*

Description

The JackStrawData is used to store the results of a JackStraw computation.

Slots

empirical.p.values Empirical p-values
 fake.reduction.scores Fake reduction scores
 empirical.p.values.full Empirical p-values on full
 overall.p.values Overall p-values from ScoreJackStraw

JackStrawData-methods *JackStrawData Methods*

Description

Methods for [JackStrawData](#) objects for generics defined in other packages

Usage

```
## S3 method for class 'JackStrawData'
.DollarNames(x, pattern = "")

## S3 method for class 'JackStrawData'
x$i, ...

## S3 method for class 'JackStrawData'
as.logical(x, ...)

## S4 method for signature 'JackStrawData'
show(object)
```

Arguments

x, object	A JackStrawData object
pattern	A regular expression. Only matching names are returned.
i	A JackStrawData slot name
...	Ignored

Value

\$: Slot i from x
 as.logical: TRUE if empirical p-values have been calculated otherwise FALSE
 show: Prints summary to [stdout](#) and invisibly returns NULL

Functions

- `.DollarNames.JackStrawData`: Autocompletion for \$ access on a [JackStrawData](#) object
- `$.JackStrawData`: Access data from a [JackStrawData](#) object
- `as.logical.JackStrawData`: Have empirical p-values for a [JackStrawData](#) object been calculated
- `show, JackStrawData-method`: Overview of a [JackStrawData](#) object

JS *Get and set JackStraw information*

Description

Get and set [JackStraw](#) information

Usage

```

JS(object, ...)

JS(object, ...) <- value

## S3 method for class 'JackStrawData'
JS(object, slot, ...)

## S3 replacement method for class 'JackStrawData'
JS(object, slot, ...) <- value

## S3 method for class 'DimReduc'
JS(object, slot = NULL, ...)

## S3 replacement method for class 'DimReduc'
JS(object, slot = NULL, ...) <- value

```

Arguments

object	An object
...	Arguments passed to other methods
value	JackStraw information
slot	Name of slot to store JackStraw scores to Can shorten to 'empirical', 'fake', 'full', or 'overall'

Value

JS: either a [JackStrawData](#) object or the specified jackstraw data

JS<-: object with the update jackstraw information

Key	<i>Get and set object keys</i>
-----	--------------------------------

Description

Get and set object keys

Usage

```
Key(object, ...)

Key(object, ...) <- value

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

## S3 replacement method for class 'Assay'
Key(object, ...) <- value

## S3 method for class 'DimReduc'
Key(object, ...)

## S3 replacement method for class 'DimReduc'
Key(object, ...) <- value

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

Arguments

object	An object
...	Arguments passed to other methods
value	Key value

Value

Key: the object key

Key<-: object with an updated key

Examples

```
# Get an Assay key
Key(pbmc_small[["RNA"]])

# Set the key for an Assay
Key(pbmc_small[["RNA"]]) <- "newkey_"
Key(pbmc_small[["RNA"]])

# Get a DimReduc key
Key(object = pbmc_small[["pca"]])

# Set the key for DimReduc
Key(object = pbmc_small[["pca"]]) <- "newkey2_"
Key(object = pbmc_small[["pca"]])

# Show all keys associated with a Seurat object
Key(object = pbmc_small)
```

Loadings

Get and set feature loadings

Description

Get and set feature loadings

Usage

```
Loadings(object, ...)

Loadings(object, ...) <- value

## S3 method for class 'DimReduc'
Loadings(object, projected = FALSE, ...)

## S3 replacement method for class 'DimReduc'
Loadings(object, projected = TRUE, ...) <- value

## S3 method for class 'Seurat'
Loadings(object, reduction = "pca", projected = FALSE, ...)
```


Arguments

object	An object
...	Arguments passed to other methods
value	Feature loadings to add
projected	Pull the projected feature loadings?
reduction	Name of reduction to pull feature loadings for

Value

Loadings: the feature loadings for object
 Loadings<-: object with the updated loadings

Examples

```
# Get the feature loadings for a given DimReduc
Loadings(object = pbmc_small[["pca"]])[1:5,1:5]

# Set the feature loadings for a given DimReduc
new.loadings <- Loadings(object = pbmc_small[["pca"]])
new.loadings <- new.loadings + 0.01
Loadings(object = pbmc_small[["pca"]]) <- new.loadings

# Get the feature loadings for a specified DimReduc in a Seurat object
Loadings(object = pbmc_small, reduction = "pca")[1:5,1:5]
```

LogSeuratCommand *Log a command*

Description

Logs command run, storing the name, timestamp, and argument list. Stores in the Seurat object

Usage

```
LogSeuratCommand(object, return.command = FALSE)
```

Arguments

object	Name of Seurat object
return.command	Return a SeuratCommand object instead

Value

If return.command, returns a SeuratCommand object. Otherwise, returns the Seurat object with command stored

See Also[Command](#)

Misc*Get and set miscellaneous data*

Description

Get and set miscellaneous data

Usage

```

Misc(object, ...)

Misc(object, ...) <- value

## S3 method for class 'Assay'
Misc(object, slot = NULL, ...)

## S3 replacement method for class 'Assay'
Misc(object, slot, ...) <- value

## S3 method for class 'DimReduc'
Misc(object, slot = NULL, ...)

## S3 replacement method for class 'DimReduc'
Misc(object, slot, ...) <- value

## S3 method for class 'Seurat'
Misc(object, slot = NULL, ...)

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

```

Arguments

<code>object</code>	An object
<code>...</code>	Arguments passed to other methods
<code>value</code>	Data to add
<code>slot</code>	Name of specific bit of meta data to pull

Value

Miscellaneous data
 An object with miscellaneous data added

Examples

```
# Get the misc info
Misc(object = pbmc_small, slot = "example")

# Add misc info
Misc(object = pbmc_small, slot = "example") <- "testing_misc"
```

Neighbor-class	<i>The Neighbor class</i>
----------------	---------------------------

Description

The Neighbor class is used to store the results of neighbor finding algorithms

Slots

nn.idx Matrix containing the nearest neighbor indices
 nn.dist Matrix containing the nearest neighbor distances
 alg.idx The neighbor finding index (if applicable). E.g. the annoy index
 alg.info Any information associated with the algorithm that may be needed downstream (e.g. distance metric used with annoy is needed when reading in from stored file).
 cell.names Names of the cells for which the neighbors have been computed.

Neighbor-methods	<i>Neighbor Methods</i>
------------------	-------------------------

Description

Methods for [Neighbor](#) objects for generics defined in other packages

Usage

```
## S3 method for class 'Neighbor'
dim(x)

## S4 method for signature 'Neighbor'
show(object)
```

Arguments

x, object A [Neighbor](#) object

Value

dim Dimensions of the indices matrix

show: Prints summary to `stdout` and invisibly returns NULL

Functions

- `dim.Neighbor`: Dimensions of the neighbor indices
- `show,Neighbor-method`: Overview of a Neighbor object

pbmc_small

A small example version of the PBMC dataset

Description

A subsetted version of 10X Genomics' 3k PBMC dataset

Usage

pbmc_small

Format

A Seurat object with the following slots filled

assays Currently only contains one assay ("RNA" - scRNA-seq expression data)

counts - Raw expression data

- data - Normalized expression data
- scale.data - Scaled expression data
- var.features - names of the current features selected as variable
- meta.features - Assay level metadata such as mean and variance

meta.data Cell level metadata

active.assay Current default assay

active.ident Current default ident

graphs Neighbor graphs computed, currently stores the SNN

reductions Dimensional reductions: currently PCA and tSNE

version Seurat version used to create the object

commands Command history

Source

<https://support.10xgenomics.com/single-cell-gene-expression/datasets/1.1.0/pbmc3k>

Project	<i>Get and set project information</i>
---------	--

Description

Get and set project information

Usage

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

Arguments

object	An object
...	Arguments passed to other methods
value	Project information to set

Value

Project information
An object with project information added

Radius	<i>Get the spot radius from an image</i>
--------	--

Description

Get the spot radius from an image

Usage

```
Radius(object)
```

Arguments

object	An image object
--------	-----------------

Value

The radius size

RenameAssays	<i>Rename assays in a Seurat object</i>
--------------	---

Description

Rename assays in a Seurat object

Usage

```
RenameAssays(object, ...)
```

Arguments

object	A Seurat object
...	Named arguments as old.assay = new.assay

Value

object with assays renamed

Examples

```
RenameAssays(object = pbmc_small, RNA = 'rna')
```

RenameCells	<i>Rename cells</i>
-------------	---------------------

Description

Change the cell names in all the different parts of an object. Can be useful before combining multiple objects.

Usage

```

RenameCells(object, ...)

## S3 method for class 'Assay'
RenameCells(object, new.names = NULL, ...)

## S3 method for class 'DimReduc'
RenameCells(object, new.names = NULL, ...)

## S3 method for class 'Neighbor'
RenameCells(object, old.names = NULL, new.names = NULL, ...)

## S3 method for class 'Seurat'
RenameCells(
  object,
  add.cell.id = NULL,
  new.names = NULL,
  for.merge = FALSE,
  ...
)

```

Arguments

object	An object
...	Arguments passed to other methods
new.names	vector of new cell names
old.names	vector of old cell names
add.cell.id	prefix to add cell names
for.merge	Only rename slots needed for merging Seurat objects. Currently only renames the raw.data and meta.data slots.

Details

If add.cell.id is set a prefix is added to existing cell names. If new.names is set these will be used to replace existing names.

Value

An object with new cell names

Examples

```

# Rename cells in an Assay
head(x = colnames(x = pbmc_small[["RNA"]]))
renamed.assay <- RenameCells(
  pbmc_small[["RNA"]],
  new.names = paste0("A_", colnames(x = pbmc_small[["RNA"]]))
)

```

```
head(x = colnames(x = renamed.assay))

# Rename cells in a DimReduc
head(x = Cells(x = pbmc_small[["pca"]]))
renamed.dimreduc <- RenameCells(
  object = pbmc_small[["pca"]],
  new.names = paste0("A_", Cells(x = pbmc_small[["pca"]]))
)
head(x = Cells(x = renamed.dimreduc))

# Rename cells in a Seurat object
head(x = colnames(x = pbmc_small))
pbmc_small <- RenameCells(object = pbmc_small, add.cell.id = "A")
head(x = colnames(x = pbmc_small))
```

RowMergeSparseMatrices

Merge Sparse Matrices by Row

Description

Merge two or more sparse matrices by rowname.

Usage

```
RowMergeSparseMatrices(mat1, mat2)
```

Arguments

mat1	First matrix
mat2	Second matrix or list of matrices

Details

Shared matrix rows (with the same row name) will be merged, and unshared rows (with different names) will be filled with zeros in the matrix not containing the row.

Value

Returns a sparse matrix

`s4list`*S4/List Conversion*

Description

Convert S4 objects to lists and vice versa. Useful for declassing an S4 object while keeping track of it's class using attributes (see section **S4 Class Definition Attributes** below for more details). Both `ListToS4` and `S4ToList` are recursive functions, affecting all lists/S4 objects contained as sub-lists/sub-objects.

Usage

```
S4ToList(object)

IsS4List(x)

ListToS4(x)

## Default S3 method:
S4ToList(object)

## S3 method for class 'list'
S4ToList(object)
```

Arguments

<code>object</code>	An S4 object
<code>x</code>	A list with an S4 class definition attribute

Value

`S4ToList`: A list with an S4 class definition attribute
`IsS4List`: TRUE if `x` is a list with an S4 class definition attribute
`ListToS4`: An S4 object as defined by the S4 class definition attribute

S4 Class Definition Attributes

S4 classes are scoped to the package and class name. In order to properly track which class a list is generated from in order to build a new one, these function use an [attribute](#) to denote the class name and package of origin. This attribute is stored as “classDef” and takes the form of “package:class”.

 Seurat-class

The Seurat Class

Description

The Seurat object is a representation of single-cell expression data for R; each Seurat object revolves around a set of cells and consists of one or more [Assay](#) objects, or individual representations of expression data (eg. RNA-seq, ATAC-seq, etc). These assays can be reduced from their high-dimensional state to a lower-dimension state and stored as [DimReduc](#) objects. Seurat objects also store additional metadata, both at the cell and feature level (contained within individual assays). The object was designed to be as self-contained as possible, and easily extendable to new methods.

Slots

assays A list of assays for this project

meta.data Contains meta-information about each cell, starting with number of features detected (nFeature) and the original identity class (orig.ident); more information is added using [AddMetaData](#)

active.assay Name of the active, or default, assay; settable using [DefaultAssay](#)

active.ident The active cluster identity for this Seurat object; settable using [Idents](#)

graphs A list of [Graph](#) objects

neighbors ...

reductions A list of dimensional reduction objects for this object

images A list of spatial image objects

project.name Name of the project

misc A list of miscellaneous information

version Version of Seurat this object was built under

commands A list of logged commands run on this Seurat object

tools A list of miscellaneous data generated by other tools, should be filled by developers only using [Tool](#)<-

 seurat-class

The Seurat Class

Description

The Seurat object is the center of each single cell analysis. It stores all information associated with the dataset, including data, annotations, analyses, etc. All that is needed to construct a Seurat object is an expression matrix (rows are genes, columns are cells), which should be log-scale

Usage

```
## S4 method for signature 'seurat'
show(object)
```

Arguments

object A [Seurat](#) object

Details

Each Seurat object has a number of slots which store information. Key slots to access are listed below.

Slots

`raw.data` The raw project data

`data` The normalized expression matrix (log-scale)

`scale.data` scaled (default is z-scoring each gene) expression matrix; used for dimensional reduction and heatmap visualization

`var.genes` Vector of genes exhibiting high variance across single cells

`is.expr` Expression threshold to determine if a gene is expressed (0 by default)

`ident` The 'identity class' for each cell

`meta.data` Contains meta-information about each cell, starting with number of genes detected (`nFeature`) and the original identity class (`orig.ident`); more information is added using `AddMetaData`

`project.name` Name of the project (for record keeping)

`dr` List of stored dimensional reductions; named by technique

`assay` List of additional assays for multimodal analysis; named by technique

`hvg.info` The output of the mean/variability analysis for all genes

`imputed` Matrix of imputed gene scores

`cell.names` Names of all single cells (column names of the expression matrix)

`cluster.tree` List where the first element is a phylo object containing the phylogenetic tree relating different identity classes

`snn` Sparse matrix object representation of the SNN graph

`calc.params` Named list to store all calculation-related parameter choices

`kmeans` Stores output of gene-based clustering from `DoKMeans`

`spatial` Stores internal data and calculations for spatial mapping of single cells

`misc` Miscellaneous spot to store any data alongside the object (for example, gene lists)

`version` Version of package used in object creation

Seurat-methods

Seurat Methods

Description

Methods for [Seurat](#) objects for generics defined in other packages

Usage

```
## S3 method for class 'Seurat'
.DollarNames(x, pattern = "")

## S3 method for class 'Seurat'
x$i, ...

## S3 replacement method for class 'Seurat'
x$i, ... <- value

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

## S3 method for class 'Seurat'
x[[i, ..., drop = FALSE]]

## S3 method for class 'Seurat'
dim(x)

## S3 method for class 'Seurat'
dimnames(x)

## S3 method for class 'Seurat'
head(x, n = 10L, ...)

## S3 method for class 'Seurat'
merge(
  x = NULL,
  y = NULL,
  add.cell.ids = NULL,
  merge.data = TRUE,
  merge.dr = NULL,
  project = "SeuratProject",
  ...
)

## S3 method for class 'Seurat'
names(x)
```

```

## S3 method for class 'Seurat'
subset(
  x,
  subset,
  cells = NULL,
  features = NULL,
  idents = NULL,
  return.null = FALSE,
  ...
)

## S3 method for class 'Seurat'
tail(x, n = 10L, ...)

## S4 replacement method for signature 'Seurat'
x[[i, j, ...]] <- value

## S4 method for signature 'Seurat'
colMeans(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Seurat'
colSums(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Seurat'
rowMeans(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Seurat'
rowSums(x, na.rm = FALSE, dims = 1, ..., slot = "data")

## S4 method for signature 'Seurat'
show(object)

```

Arguments

x, object	A Seurat object
pattern	A regular expression. Only matching names are returned.
i, features	Depends on the method [, subset Feature names or indices \$, \$<- Name of a single metadata column [[, [[<- Name of one or more metadata columns or an associated object; associated objects include Assay , DimReduc , Graph , SeuratCommand , or SpatialImage objects
...	Arguments passed to other methods
value	Additional metadata or associated objects to add; note : can pass NULL to remove metadata or an associated object
j, cells	Cell names or indices

drop	See drop
n	The number of rows of metadata to return
y	A single Seurat object or a list of Seurat objects
add.cell.ids	A character vector of length($x = c(x, y)$); appends the corresponding values to the start of each objects' cell names
merge.data	Merge the data slots instead of just merging the counts (which requires renormalization); this is recommended if the same normalization approach was applied to all objects
merge.dr	Merge specified DimReducs that are present in all objects; will only merge the embeddings slots for the first N dimensions that are shared across all objects.
project	Project name for the Seurat object
subset	Logical expression indicating features/variables to keep
idents	A vector of identity classes to keep
return.null	If no cells are request, return a NULL; by default, throws an error
na.rm	logical. Should missing values (including NaN) be omitted from the calculations?
dims	completely ignored by the <i>Matrix</i> methods.
slot	Name of assay expression matrix to calculate column/row means/sums on

Value

`$`: metadata column `i` for object `x`; **note**: unlike `[[`, `$` drops the shape of the metadata to return a vector instead of a data frame

`$<-`: object `x` with metadata value saved as `i`

`[`: object `x` with features `i` and cells `j`

`[[`: If `i` is missing, the metadata data frame; if `i` is a vector of metadata names, a data frame with the requested metadata, otherwise, the requested associated object

`dim`: The number of features (`nrow`) and cells (`ncol`) for the default assay; **note**: while the number of features changes depending on the active assay, the number of cells remains the same across all assays

`dimnames`: The feature (row) and cell (column) names; **note**: while the features change depending on the active assay, the cell names remain the same across all assays

`head`: The first `n` rows of cell-level metadata

`merge`: Merged object

`names`: The names of all [Assay](#), [DimReduc](#), [Graph](#), and [SpatialImage](#) objects in the Seurat object

`subset`: A subsetted Seurat object

`tail`: The last `n` rows of cell-level metadata

`[[<-`: `x` with the metadata or associated objects added as `i`; if `value` is NULL, removes metadata or associated object `i` from object `x`

`show`: Prints summary to [stdout](#) and invisibly returns NULL

Functions

- `.DollarNames.Seurat`: Autocompletion for `$` access on a Seurat object
- `$.Seurat`: Metadata access for Seurat objects
- `$<- .Seurat`: Metadata setter for Seurat objects
- `[.Seurat`: Simple subsetter for Seurat objects
- `[[.Seurat`: Metadata and associated object accessor
- `dim.Seurat`: Number of cells and features for the active assay
- `dimnames.Seurat`: The cell and feature names for the active assay
- `head.Seurat`: Get the first rows of cell-level metadata
- `merge.Seurat`: Merge two or more Seurat objects together
- `names.Seurat`: Common associated objects
- `subset.Seurat`: Subset a [Seurat](#) object
- `tail.Seurat`: Get the last rows of cell-level metadata
- `[[<-, Seurat-method`: Add cell-level metadata or associated objects
- `colMeans, Seurat-method`: Calculate [colMeans](#) on a Seurat object
- `colSums, Seurat-method`: Calculate [colSums](#) on a Seurat object
- `rowMeans, Seurat-method`: Calculate [rowMeans](#) on a rowMeans object
- `rowSums, Seurat-method`: Calculate [rowSums](#) on a Seurat object
- `show, Seurat-method`: Overview of a Seurat object

Merge Details

When merging Seurat objects, the merge procedure will merge the Assay level counts and potentially the data slots (depending on the `merge.data` parameter). It will also merge the cell-level metadata that was stored with each object and preserve the cell identities that were active in the objects pre-merge. The merge will optionally merge reductions depending on the values passed to `merge.dr` if they have the same name across objects. Here the embeddings slots will be merged and if there are differing numbers of dimensions across objects, only the first N shared dimensions will be merged. The feature loadings slots will be filled by the values present in the first object. The merge will not preserve graphs, logged commands, or feature-level metadata that were present in the original objects. If `add.cell.ids` isn't specified and any cell names are duplicated, cell names will be appended with `_X`, where X is the numeric index of the object in `c(x, y)`.

See Also

[subset WhichCells](#)

Examples

```
# Get metadata using `$$`  
head(pbmc_small$groups)  
  
# Add metadata using the `$$` operator  
set.seed(42)
```

```
pbmc_small$value <- sample(1:3, size = ncol(pbmc_small), replace = TRUE)
head(pbmc_small[["value"]])

# `[` examples
pbmc_small[VariableFeatures(object = pbmc_small), ]
pbmc_small[, 1:10]

# Get the cell-level metadata data frame
head(pbmc_small[[]])

# Pull specific metadata information
head(pbmc_small[[c("letter.idents", "groups")]])
head(pbmc_small[["groups", drop = TRUE]])

# Get a sub-object (eg. an `Assay` or `DimReduc`)
pbmc_small[["RNA"]]
pbmc_small[["pca"]]

# Get the number of features in an object
nrow(pbmc_small)

# Get the number of cells in an object
ncol(pbmc_small)

# Get the feature names of an object
rownames(pbmc_small)

# Get the cell names of an object
colnames(pbmc_small)

# Get the first 10 rows of cell-level metadata
head(pbmc_small)

# `merge` examples
# merge two objects
merge(pbmc_small, y = pbmc_small)
# to merge more than two objects, pass one to x and a list of objects to y
merge(pbmc_small, y = c(pbmc_small, pbmc_small))

names(pbmc_small)

# `subset` examples
subset(pbmc_small, subset = MS4A1 > 4)
subset(pbmc_small, subset = `DLGAP1-AS1` > 2)
subset(pbmc_small, idents = '0', invert = TRUE)
subset(pbmc_small, subset = MS4A1 > 3, slot = 'counts')
subset(pbmc_small, features = VariableFeatures(object = pbmc_small))

# Get the last 10 rows of cell-level metadata
tail(pbmc_small)

head(colMeans(pbmc_small))
```



```

head(colSums(pbmc_small))

head(rowMeans(pbmc_small))

head(rowSums(pbmc_small))

```

SeuratCommand-class *The SeuratCommand Class*

Description

The SeuratCommand is used for logging commands that are run on a Seurat object; it stores parameters and timestamps

Slots

name Command name
time.stamp Timestamp of when command was tun
assay.used Optional name of assay used to generate SeuratCommand object
call.string String of the command call
params List of parameters used in the command call

SeuratCommand-methods *SeuratCommand Methods*

Description

Methods for [SeuratCommand](#) objects for generics defined in other packages

Usage

```

## S3 method for class 'SeuratCommand'
.DollarNames(x, pattern = "")

## S3 method for class 'SeuratCommand'
x$i, ...

## S3 method for class 'SeuratCommand'
x[i, ...]

## S3 method for class 'SeuratCommand'
as.list(x, complete = FALSE, ...)

## S4 method for signature 'SeuratCommand'
show(object)

```

Arguments

x, object	A SeuratCommand object
pattern	A regular expression. Only matching names are returned.
i	For a \$, a parameter name; for [, a SeuratCommand slot name
...	Arguments passed to other methods
complete	Include slots besides just parameters (eg. call string, name, timestamp)

Value

\$: The value for parameter i

[: Slot i from x

as.list: A list with the parameters and, if complete = TRUE, the call string, name, and timestamp

show: Prints summary to [stdout](#) and invisibly returns NULL

Functions

- `.DollarNames.SeuratCommand`: Autocompletion for \$ access on a SeuratCommand object
- `$.SeuratCommand`: Access a parameter from a SeuratCommand object
- `[.SeuratCommand`: Access data from a SeuratCommand object
- `as.list.SeuratCommand`: Coerce a SeuratCommand to a list
- `show,SeuratCommand-method`: Overview of a SeuratCommand object

SpatialImage-class *The SpatialImage class*

Description

The `SpatialImage` class is a virtual class representing spatial information for Seurat. All spatial image information must inherit from this class for use with Seurat objects

Slots

assay Name of assay to associate image data with; will give this image priority for visualization when the assay is set as the active/default assay in a Seurat object

key Key for the image

See Also

[SpatialImage-methods](#) for a list of required and provided methods

Description

Methods defined on the [SpatialImage](#) class. Some of these methods must be overridden in order to ensure proper functionality of the derived classes (see **Required methods** below). Other methods are designed to work across all SpatialImage-derived subclasses, and should only be overridden if necessary

Usage

```
## S3 method for class 'SpatialImage'  
Cells(x)  
  
## S3 method for class 'SpatialImage'  
DefaultAssay(object, ...)  
  
## S3 replacement method for class 'SpatialImage'  
DefaultAssay(object, ...) <- value  
  
## S3 method for class 'SpatialImage'  
GetImage(object, mode = c("grob", "raster", "plotly", "raw"), ...)  
  
## S3 method for class 'SpatialImage'  
GetTissueCoordinates(object, ...)  
  
## S3 method for class 'SpatialImage'  
IsGlobal(object, ...)  
  
## S3 method for class 'SpatialImage'  
Key(object, ...)  
  
## S3 replacement method for class 'SpatialImage'  
Key(object, ...) <- value  
  
## S3 method for class 'SpatialImage'  
Radius(object)  
  
## S3 method for class 'SpatialImage'  
RenameCells(object, new.names = NULL, ...)  
  
## S3 method for class 'SpatialImage'  
x[i, ...]  
  
## S3 method for class 'SpatialImage'  
dim(x)
```

```
## S3 method for class 'SpatialImage'
subset(x, cells, ...)

## S4 method for signature 'SpatialImage'
show(object)
```

Arguments

x, object	A SpatialImage-derived object
...	Arguments passed to other methods
value	Depends on the method: DefaultAssay<- Assay that the image should be associated with Key<- New key for the image
mode	How to return the image; should accept one of “grob”, “raster”, “plotly”, or “raw”
new.names	vector of new cell names
i, cells	A vector of cells to keep

Value

[Override] Cells: should return cell names

DefaultAssay: The associated assay of a SpatialImage-derived object

DefaultAssay<-: object with the associated assay updated

[Override] GetImage: The image data from a SpatialImage-derived object

[Override] GetTissueCoordinates: ...

IsGlobal: returns TRUE as images are, by default, global

Key: The key for a SpatialImage-derived object

Key<-: object with the key set to value

Radius: The spot radius size; by default, returns NULL

[Override] RenameCells: object with the new cell names

[, subset: x/object for only the cells requested

[Override] dim: The dimensions of the image data in (Y, X) format

show: Prints summary to [stdout](#) and invisibly returns NULL

Functions

- Cells.SpatialImage: Get the cell names from an image (**[Override]**)
- DefaultAssay.SpatialImage: Get the associated assay of a SpatialImage-derived object
- DefaultAssay<-.SpatialImage: Set the associated assay of a SpatialImage-derived object
- GetImage.SpatialImage: Get the image data from a SpatialImage-derived object

- `GetTissueCoordinates.SpatialImage`: Get tissue coordinates for a `SpatialImage`-derived object (**[Override]**)
- `IsGlobal.SpatialImage`: Globality test for `SpatialImage`-derived object
- `Key.SpatialImage`: Get the key for a `SpatialImage`-derived object
- `Key<- .SpatialImage`: Set the key for a `SpatialImage`-derived object
- `Radius.SpatialImage`: Get the spot radius size
- `RenameCells.SpatialImage`: Rename cells in a `SpatialImage`-derived object (**[Override]**)
- `[.SpatialImage`: Subset a `SpatialImage`-derived object
- `dim.SpatialImage`: Get the plotting dimensions of an image (**[Override]**)
- `subset.SpatialImage`: Subset a `SpatialImage`-derived object (**[Override]**)
- `show, SpatialImage-method`: Overview of a `SpatialImage`-derived object

Provided methods

These methods are defined on the `SpatialImage` object and should not be overridden without careful thought

- `DefaultAssay` and `DefaultAssay<-`
- `Key` and `Key<-`
- `GetImage`; this method *can* be overridden to provide image data, normally returns empty image data. If overridden, should default to returning a `grob` object
- `IsGlobal`
- `Radius`; this method *can* be overridden to provide a spot radius for image objects
- `[`; this method *can* be overridden to change default subset behavior, normally returns `subset(x = x, cells = i)`. If overridden, should only accept `i`

Required methods

All subclasses of the `SpatialImage` class must define the following methods; simply relying on the `SpatialImage` method will result in errors. For required parameters and their values, see the `Usage` and `Arguments` sections

`Cells` Return the cell/spot barcodes associated with each position

`dim` Return the dimensions of the image for plotting in (Y, X) format

`GetTissueCoordinates` Return tissue coordinates; by default, must return a two-column `data.frame` with x-coordinates in the first column and y-coordinates in the second

`Radius` Return the spot radius; returns NULL by default for use with non-spot image technologies

`RenameCells` Rename the cell/spot barcodes for this image

`subset` Subset the image data by cells/spots

These methods are used throughout Seurat, so defining them and setting the proper defaults will allow subclasses of `SpatialImage` to work seamlessly

See Also

[DefaultAssay](#)
[GetImage](#)
[GetTissueCoordinates](#)
[IsGlobal](#)
[Key](#)
[RenameCells](#)

Stdev

Get the standard deviations for an object

Description

Get the standard deviations for an object

Usage

```
Stdev(object, ...)  
  
## S3 method for class 'DimReduc'  
Stdev(object, ...)  
  
## S3 method for class 'Seurat'  
Stdev(object, reduction = "pca", ...)
```

Arguments

object	An object
...	Arguments passed to other methods
reduction	Name of reduction to use

Value

The standard deviations

Examples

```
# Get the standard deviations for each PC from the DimReduc object  
Stdev(object = pbmc_small[["pca"]])  
  
# Get the standard deviations for each PC from the Seurat object  
Stdev(object = pbmc_small, reduction = "pca")
```

Tool	<i>Get and set additional tool data</i>
------	---

Description

Use Tool to get tool data. If no additional arguments are provided, will return a vector with the names of tools in the object.

Usage

```
Tool(object, ...)  
  
Tool(object, ...) <- value  
  
## S3 method for class 'Seurat'  
Tool(object, slot = NULL, ...)  
  
## S3 replacement method for class 'Seurat'  
Tool(object, ...) <- value
```

Arguments

object	An object
...	Arguments passed to other methods
value	Information to be added to tool list
slot	Name of tool to pull

Value

If no additional arguments, returns the names of the tools in the object; otherwise returns the data placed by the tool requested

Note

For developers: set tool data using Tool<-. Tool<- will automatically set the name of the tool to the function that called Tool<-, so each function gets one entry in the tools list and cannot overwrite another function's entry. The automatic naming will also remove any method identifiers (eg. RunPCA.Seurat will become RunPCA); please plan accordingly.

Examples

```
Tool(object = pbmc_small)  
  
## Not run:  
sample.tool.output <- matrix(data = rnorm(n = 16), nrow = 4)  
# must be run from within a function  
Tool(object = pbmc_small) <- sample.tool.output
```

```
## End(Not run)
```

```
UpdateSeuratObject      Update old Seurat object to accommodate new features
```

Description

Updates Seurat objects to new structure for storing data/calculations. For Seurat v3 objects, will validate object structure ensuring all keys and feature names are formed properly.

Usage

```
UpdateSeuratObject(object)
```

Arguments

```
object          Seurat object
```

Value

Returns a Seurat object compatible with latest changes

Examples

```
## Not run:
updated_seurat_object = UpdateSeuratObject(object = old_seurat_object)

## End(Not run)
```

```
Version      Get Version Information
```

Description

Get Version Information

Usage

```
Version(object, ...)

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


Arguments

object	An object
...	Arguments passed to other methods

Examples

```
Version(pbmc_small)
```

WhichCells	<i>Identify cells matching certain criteria</i>
------------	---

Description

Returns a list of cells that match a particular set of criteria such as identity class, high/low values for particular PCs, etc.

Usage

```
WhichCells(object, ...)

## S3 method for class 'Assay'
WhichCells(object, cells = NULL, expression, invert = FALSE, ...)

## S3 method for class 'Seurat'
WhichCells(
  object,
  cells = NULL,
  idents = NULL,
  expression,
  slot = "data",
  invert = FALSE,
  downsample = Inf,
  seed = 1,
  ...
)
```

Arguments

object	An object
...	Arguments passed on to CellsByIdentities
	<code>return.null</code> If no cells are request, return a NULL; by default, throws an error
cells	Subset of cell names

expression	A predicate expression for feature/variable expression, can evaluate anything that can be pulled by FetchData; please note, you may need to wrap feature names in backticks (``) if dashes between numbers are present in the feature name
invert	Invert the selection of cells
idents	A vector of identity classes to keep
slot	Slot to pull feature data for
downsample	Maximum number of cells per identity class, default is Inf; downsampling will happen after all other operations, including inverting the cell selection
seed	Random seed for downsampling. If NULL, does not set a seed

Value

A vector of cell names

See Also

[FetchData](#)

Examples

```
WhichCells(pbmc_small, idents = 2)
WhichCells(pbmc_small, expression = MS4A1 > 3)
levels(pbmc_small)
WhichCells(pbmc_small, idents = c(1, 2), invert = TRUE)
```

Index

- * **assay**
 - Assay-class, 8
 - Assay-methods, 8
 - CreateAssayObject, 17
- * **command**
 - LogSeuratCommand, 41
 - SeuratCommand-methods, 57
- * **data-access**
 - AssayData, 11
 - Assays, 12
 - Cells, 14
 - CellsByIdentities, 15
 - CellsByImage, 15
 - Command, 16
 - DefaultAssay, 21
 - Distances, 25
 - Embeddings, 25
 - FetchData, 26
 - GetImage, 27
 - GetTissueCoordinates, 28
 - HVFInfo, 29
 - Images, 34
 - Index, 34
 - Indices, 35
 - IsGlobal, 36
 - Key, 39
 - Loadings, 40
 - Misc, 42
 - Stdev, 62
 - Tool, 63
 - Version, 64
 - WhichCells, 65
- * **datasets**
 - pbmc_small, 44
- * **dimreduc**
 - CreateDimReducObject, 18
 - DimReduc-methods, 23
- * **graph**
 - as.Graph, 5
- * **jackstraw**
 - JackStrawData-methods, 37
 - JS, 38
- * **neighbor**
 - as.Neighbor, 6
 - Neighbor-methods, 43
- * **seurat**
 - AddMetaData, 4
 - as.Seurat, 7
 - CreateSeuratObject, 19
 - Idents, 31
 - Project, 45
 - RenameAssays, 46
 - RenameCells, 46
 - Seurat-methods, 52
 - UpdateSeuratObject, 64
- * **spatialimage**
 - Radius, 45
 - SpatialImage-methods, 59
- * **unsorted**
 - seurat-class, 50
- * **utils**
 - as.sparse, 7
 - AttachDeps, 13
 - CheckGC, 16
 - IsMatrixEmpty, 36
 - RowMergeSparseMatrices, 48
 - s4list, 49
 - .DollarNames.JackStrawData
 - (JackStrawData-methods), 37
 - .DollarNames.Seurat (Seurat-methods), 52
 - .DollarNames.SeuratCommand
 - (SeuratCommand-methods), 57
 - .onAttach, 13
 - [, 61
 - [.Assay (Assay-methods), 8
 - [.DimReduc (DimReduc-methods), 23
 - [.Seurat (Seurat-methods), 52
 - [.SeuratCommand

- (SeuratCommand-methods), 57
- [.SpatialImage (SpatialImage-methods), 59
- [[.Assay (Assay-methods), 8
- [[.DimReduc (DimReduc-methods), 23
- [[.Seurat (Seurat-methods), 52
- [[<- , Assay-method (Assay-methods), 8
- [[<- , Seurat-method (Seurat-methods), 52
- \$.JackStrawData
 - (JackStrawData-methods), 37
- \$.Seurat (Seurat-methods), 52
- \$.SeuratCommand
 - (SeuratCommand-methods), 57
- \$<- .Seurat (Seurat-methods), 52
- AddMetaData, 4, 50
- AddSamples (Seurat-methods), 52
- as.Graph, 5
- as.list.SeuratCommand
 - (SeuratCommand-methods), 57
- as.logical.JackStrawData
 - (JackStrawData-methods), 37
- as.Neighbor, 6
- as.Seurat, 7
- as.sparse, 7, 17
- Assay, 8, 9, 11, 12, 17, 20, 29, 50, 53, 54
- Assay (Assay-class), 8
- Assay-class, 8
- Assay-methods, 8
- AssayData, 11
- Assays, 12
- AttachDeps, 13
- attribute, 49
- cat, 25
- Cells, 14, 61
- Cells.SpatialImage
 - (SpatialImage-methods), 59
- CellsByIdentities, 15, 65
- CellsByImage, 15
- CheckGC, 16
- colMeans, 11, 55
- colMeans, Assay-method (Assay-methods), 8
- colMeans, Seurat-method
 - (Seurat-methods), 52
- colSums, 11, 55
- colSums, Assay-method (Assay-methods), 8
- colSums, Seurat-method (Seurat-methods), 52
- Command, 16, 42
- CreateAssayObject, 17
- CreateDimReducObject, 18
- CreateSeuratObject, 19
- data.frame, 20
- default assay, 12
- DefaultAssay, 21, 50, 61, 62
- DefaultAssay.SpatialImage
 - (SpatialImage-methods), 59
- DefaultAssay<- (DefaultAssay), 21
- DefaultAssay<- .SpatialImage
 - (SpatialImage-methods), 59
- dgCMatix, 28
- dim, 61
- dim.Assay (Assay-methods), 8
- dim.DimReduc (DimReduc-methods), 23
- dim.Neighbor (Neighbor-methods), 43
- dim.Seurat (Seurat-methods), 52
- dim.SpatialImage
 - (SpatialImage-methods), 59
- dimnames.Assay (Assay-methods), 8
- dimnames.DimReduc (DimReduc-methods), 23
- dimnames.Seurat (Seurat-methods), 52
- DimReduc, 12, 19, 23, 24, 50, 53, 54
- DimReduc (DimReduc-class), 22
- DimReduc-class, 22
- DimReduc-methods, 23
- Distances, 25
- drop, 10, 24, 54
- droplevels.Seurat (Idents), 31
- Embeddings, 25
- FetchData, 26, 32, 66
- GetAssayData (AssayData), 11
- GetImage, 27, 61, 62
- GetImage.SpatialImage
 - (SpatialImage-methods), 59
- GetTissueCoordinates, 28, 61, 62
- GetTissueCoordinates.SpatialImage
 - (SpatialImage-methods), 59
- Graph, 5, 6, 12, 50, 53, 54
- Graph (Graph-class), 28
- Graph-class, 28
- Graphs (Assays), 12
- grob, 61
- head.Assay (Assay-methods), 8

- head.Seurat (Seurat-methods), 52
- HVFInfo, 29
- Idents, 31, 50
- Idents<- (Idents), 31
- Images, 34
- Index, 34
- Index<- (Index), 34
- Indices, 35
- IsGlobal, 36, 61, 62
- IsGlobal.SpatialImage
(SpatialImage-methods), 59
- IsMatrixEmpty, 36
- IsS4List (s4list), 49
- JackStrawData, 37–39
- JackStrawData (JackStrawData-class), 37
- JackStrawData-class, 37
- JackStrawData-methods, 37
- JS, 38
- JS<- (JS), 38
- Key, 39, 61, 62
- Key.SpatialImage
(SpatialImage-methods), 59
- Key<- (Key), 39
- Key<- .SpatialImage
(SpatialImage-methods), 59
- layout, 27
- length.DimReduc (DimReduc-methods), 23
- levels.Seurat (Idents), 31
- levels<- .Seurat (Idents), 31
- ListToS4 (s4list), 49
- Loadings, 40
- Loadings<- (Loadings), 40
- LogSeuratCommand, 41
- Matrix, 5
- matrix, 5, 20
- mean, 32
- merge (Seurat-methods), 52
- merge.Assay (Assay-methods), 8
- merge.DimReduc (DimReduc-methods), 23
- MergeSeurat (Seurat-methods), 52
- Misc, 42
- Misc<- (Misc), 42
- names.DimReduc (DimReduc-methods), 23
- names.Seurat (Seurat-methods), 52
- Neighbor, 6, 12, 43
- Neighbor (Neighbor-class), 43
- Neighbor-class, 43
- Neighbor-methods, 43
- Neighbors (Assays), 12
- pbmc_small, 44
- plotly:::layout, 27
- print (DimReduc-methods), 23
- Project, 20, 45, 54
- Project<- (Project), 45
- Radius, 45, 61
- Radius.SpatialImage
(SpatialImage-methods), 59
- Reductions (Assays), 12
- RenameAssays, 46
- RenameCells, 46, 61, 62
- RenameCells.SpatialImage
(SpatialImage-methods), 59
- RenameIdent (Idents), 31
- RenameIdents (Idents), 31
- ReorderIdent (Idents), 31
- rowMeans, 11, 55
- rowMeans, Assay-method (Assay-methods), 8
- rowMeans, Seurat-method
(Seurat-methods), 52
- RowMergeSparseMatrices, 48
- rowSums, 11, 55
- rowSums, Assay-method (Assay-methods), 8
- rowSums, Seurat-method (Seurat-methods), 52
- s4list, 49
- S4ToList (s4list), 49
- SetAssayData (AssayData), 11
- SetDimReduction (CreateDimReducObject), 18
- SetIdent (Idents), 31
- Seurat, 7, 13, 20, 51–53, 55
- Seurat (Seurat-class), 50
- seurat (seurat-class), 50
- Seurat-class, 50
- seurat-class, 50
- Seurat-methods, 52
- SeuratAccess (AddMetaData), 4
- SeuratCommand, 41, 53, 57, 58
- SeuratCommand (SeuratCommand-class), 57
- SeuratCommand-class, 57

SeuratCommand-methods, [57](#)
SeuratObject (SeuratObject-package), [3](#)
SeuratObject-package, [3](#)
show, Assay-method (Assay-methods), [8](#)
show, DimReduc-method
 (DimReduc-methods), [23](#)
show, JackStrawData-method
 (JackStrawData-methods), [37](#)
show, Neighbor-method
 (Neighbor-methods), [43](#)
show, Seurat-method (Seurat-methods), [52](#)
show, seurat-method (seurat-class), [50](#)
show, SeuratCommand-method
 (SeuratCommand-methods), [57](#)
show, SpatialImage-method
 (SpatialImage-methods), [59](#)
SpatialImage, [53](#), [54](#), [59](#)
SpatialImage (SpatialImage-class), [58](#)
SpatialImage-class, [58](#)
SpatialImage-methods, [59](#)
SpatiallyVariableFeatures (HVFInfo), [29](#)
StashIdent (Idents), [31](#)
Stdev, [62](#)
stdout, [10](#), [24](#), [38](#), [44](#), [54](#), [58](#), [60](#)
subset, [55](#), [61](#)
subset (Seurat-methods), [52](#)
subset.Assay (Assay-methods), [8](#)
subset.DimReduc (DimReduc-methods), [23](#)
subset.SpatialImage
 (SpatialImage-methods), [59](#)
SVFInfo (HVFInfo), [29](#)

tail.Assay (Assay-methods), [8](#)
tail.Seurat (Seurat-methods), [52](#)
Tool, [50](#), [63](#)
Tool<- (Tool), [63](#)
Tools (Tool), [63](#)

UpdateSeuratObject, [64](#)

VariableFeatures (HVFInfo), [29](#)
VariableFeatures<- (HVFInfo), [29](#)
Version, [64](#)

WhichCells, [55](#), [65](#)