

# Package ‘BiocGenerics’

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**Title** Generic functions for Bioconductor

**Description** S4 generic functions needed by many other Bioconductor packages.

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BiocGenerics-package    *Generic functions for Bioconductor*

---

## Description

S4 generic functions needed by many other Bioconductor packages.

## Details

We divide the generic functions defined in the BiocGenerics package in 2 categories: (1) functions already defined in base R and explicitly promoted to generics in BiocGenerics, and (2) Bioconductor specific generics.

### (1) Functions defined in base R and explicitly promoted to generics in the BiocGenerics package:

From package base:

- BiocGenerics::cbind, BiocGenerics::rbind
- BiocGenerics::duplicated, BiocGenerics::anyDuplicated
- BiocGenerics::eval
- Extremes: BiocGenerics::pmax, BiocGenerics::pmin, BiocGenerics::pmax.int, BiocGenerics::pmin.int
- funprog: BiocGenerics::Reduce, BiocGenerics::Filter, BiocGenerics::Find, BiocGenerics::Map, BiocGenerics::Position
- BiocGenerics::get, BiocGenerics::mget
- BiocGenerics::lapply, BiocGenerics::sapply
- BiocGenerics::mapply
- BiocGenerics::nrow, BiocGenerics::ncol, BiocGenerics::NROW, BiocGenerics::NCOL
- BiocGenerics::order
- BiocGenerics::paste
- BiocGenerics::rep.int
- BiocGenerics::rownames, BiocGenerics::colnames
- sets: BiocGenerics::union, BiocGenerics::intersect, BiocGenerics::setdiff
- BiocGenerics::table

- `BiocGenerics::tapply`
- `BiocGenerics::unique`

From package graphics:

- `BiocGenerics::boxplot`
- `BiocGenerics::image`

From package stats:

- `BiocGenerics::density`
- `BiocGenerics::residuals`
- `BiocGenerics::weights`
- `BiocGenerics::xtabs`

## (2) Bioconductor specific generics:

- `combine`
- `strand, strand<-`
- `updateObject`

## Note

More generics can be added on request by sending an email to the Bioc-devel mailing list:

<http://bioconductor.org/help/mailling-list/>

Things that should NOT be added to the BiocGenerics package:

- Internal generic primitive functions like `length`, `dim`, `'dim<-'`, etc... See `?InternalMethods` for the complete list. There are a few exceptions though, that is, the BiocGenerics package may actually redefine a few of those internal generic primitive functions as S4 generics when for example the signature of the internal generic primitive is not appropriate (this is the case for `BiocGenerics::cbind`).
- S3 and S4 group generic functions like `Math`, `Ops`, etc... See `?groupGeneric` and `?S4groupGeneric` for the complete list.
- Generics already defined in the stats4 package.

## Author(s)

The Bioconductor Dev Team

## See Also

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`setGeneric` and `setMethod` for defining generics and methods.

## Examples

```
## List all the symbols defined in this package:  
ls('package:BiocGenerics')
```

---

boxplot

*Box plots*

---

## Description

Produce box-and-whisker plot(s) of the given (grouped) values.

NOTE: This man page is for the boxplot S4 generic function defined in the BiocGenerics package. See `?graphics::boxplot` for the default method (defined in the graphics package). Bioconductor packages can define specific methods for objects not supported by the default method.

## Usage

```
boxplot(x, ...)
```

## Arguments

`x, ...` See `?graphics::boxplot`.

## Value

See `?graphics::boxplot` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

## See Also

`graphics::boxplot` for the default boxplot method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`boxplot,FeatureSet-method` in the oligo package for the method defined for `FeatureSet` objects.

`BiocGenerics` for a summary of all the generics defined in the BiocGenerics package.

## Examples

```
boxplot
showMethods("boxplot")
selectMethod("boxplot", "ANY") # the default method
```

---

`cbind`*Combine R objects by rows or columns*

---

## Description

`cbind` and `rbind` take a sequence of R objects arguments and combine them by columns or rows, respectively.

NOTE: This man page is for the `cbind` and `rbind` S4 generic functions defined in the `BiocGenerics` package. See `?base::cbind` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like or matrix-like) not supported by the default methods.

## Usage

```
cbind(..., deparse.level=1)
rbind(..., deparse.level=1)
```

## Arguments

`...` One or more vector-like or matrix-like R objects. These can be given as named arguments.

`deparse.level` See `?base::cbind` for a description of this argument.

## Value

See `?base::cbind` for the value returned by the default methods.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input objects.

## See Also

`base::cbind` for the default `cbind` and `rbind` methods.

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[cbind,DataFrame-method](#) in the `IRanges` package for the `cbind` method defined for `DataFrame` objects.

[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
cbind # note the dispatch on the '...' arg only
showMethods("cbind")
selectMethod("cbind", "ANY") # the default method

rbind # note the dispatch on the '...' arg only
showMethods("rbind")
selectMethod("rbind", "ANY") # the default method
```

---

`combine`*Combining or merging different Bioconductor data structures*

---

### Description

The `combine` generic function handles methods for combining or merging different Bioconductor data structures. It should, given an arbitrary number of arguments of the same class (possibly by inheritance), combine them into a single instance in a sensible way (some methods may only combine 2 objects, ignoring ... in the argument list; because Bioconductor data structures are complicated, check carefully that `combine` does as you intend).

### Usage

```
combine(x, y, ...)
```

### Arguments

<code>x</code>	One of the values.
<code>y</code>	A second value.
<code>...</code>	Any other objects of the same class as <code>x</code> and <code>y</code> .

### Details

There are two basic `combine` strategies. One is an intersection strategy. The returned value should only have rows (or columns) that are found in all input data objects. The union strategy says that the return value will have all rows (or columns) found in any one of the input data objects (in which case some indication of what to use for missing values will need to be provided).

These functions and methods are currently under construction. Please let us know if there are features that you require.

### Value

A single value of the same class as the most specific common ancestor (in class terms) of the input values. This will contain the appropriate combination of the data in the input values.

### Methods

The following methods are defined in the `BiocGenerics` package:

`combine(x=ANY, missing)` Return the first (`x`) argument unchanged.

`combine(data.frame, data.frame)` Combines two `data.frame` objects so that the resulting `data.frame` contains all rows and columns of the original objects. Rows and columns in the returned value are unique, that is, a row or column represented in both arguments is represented only once in the result. To perform this operation, `combine` makes sure that data in shared rows and columns are identical in the two `data.frames`. Data differences in shared rows and columns usually cause an error. `combine` issues a warning when a column is a `factor` and the levels of the factor in the two `data.frames` are different.

`combine(matrix, matrix)` Combined two matrix objects so that the resulting matrix contains all rows and columns of the original objects. Both matrices must have dimnames. Rows and columns in the returned value are unique, that is, a row or column represented in both arguments is represented only once in the result. To perform this operation, `combine` makes sure that data in shared rows and columns are all equal in the two matrices.

Additional `combine` methods are defined in the Biobase package for [AnnotatedDataFrame](#), [AssayData](#), [MIAME](#), and [eSet](#) objects.

### Author(s)

Biocore

### See Also

[combine](#), [AnnotatedDataFrame](#), [AnnotatedDataFrame-method](#), [combine](#), [AssayData](#), [AssayData-method](#), [combine](#), [MIAME](#), [MIAME-method](#), and [combine](#), [eSet](#), [eSet-method](#) in the Biobase package for additional `combine` methods.

[merge](#) for merging two data frames (or data.frame-like) R objects.

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[BiocGenerics](#) for a summary of all the generics defined in the BiocGenerics package.

### Examples

```
combine
showMethods("combine")
selectMethod("combine", c("ANY", "missing"))
selectMethod("combine", c("data.frame", "data.frame"))
selectMethod("combine", c("matrix", "matrix"))

## -----
## COMBINING TWO DATA FRAMES
## -----
x <- data.frame(x=1:5,
                y=factor(letters[1:5], levels=letters[1:8]),
                row.names=letters[1:5])
y <- data.frame(z=3:7,
                y=factor(letters[3:7], levels=letters[1:8]),
                row.names=letters[3:7])
combine(x,y)

w <- data.frame(w=4:8,
                y=factor(letters[4:8], levels=letters[1:8]),
                row.names=letters[4:8])
combine(w, x, y)

# y is converted to 'factor' with different levels
df1 <- data.frame(x=1:5,y=letters[1:5], row.names=letters[1:5])
df2 <- data.frame(z=3:7,y=letters[3:7], row.names=letters[3:7])
try(combine(df1, df2)) # fails
# solution 1: ensure identical levels
y1 <- factor(letters[1:5], levels=letters[1:7])
y2 <- factor(letters[3:7], levels=letters[1:7])
df1 <- data.frame(x=1:5,y=y1, row.names=letters[1:5])
```

```
df2 <- data.frame(z=3:7,y=y2, row.names=letters[3:7])
combine(df1, df2)
# solution 2: force column to be 'character'
df1 <- data.frame(x=1:5,y=I(letters[1:5]), row.names=letters[1:5])
df2 <- data.frame(z=3:7,y=I(letters[3:7]), row.names=letters[3:7])
combine(df1, df2)

## -----
## COMBINING TWO MATRICES
## -----
m <- matrix(1:20, nrow=5, dimnames=list(LETTERS[1:5], letters[1:4]))
combine(m[1:3,], m[4:5,])
combine(m[1:3, 1:3], m[3:5, 3:4]) # overlap
```

---

connection-class	<i>S4 connection classes</i>
------------------	------------------------------

---

### Description

These are S4 representations of the S3 connection classes in R. They exist only to support method dispatch on connection types.

---

density	<i>Kernel density estimation</i>
---------	----------------------------------

---

### Description

The generic function `density` computes kernel density estimates.

NOTE: This man page is for the `density` S4 generic function defined in the `BiocGenerics` package. See `?stats::density` for the default method (defined in the `stats` package). Bioconductor packages can define specific methods for objects not supported by the default method.

### Usage

```
density(x, ...)
```

### Arguments

`x, ...` See `?stats::density`.

### Value

See `?stats::density` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.



**See Also**

`stats::density` for the default density method.  
[showMethods](#) for displaying a summary of the methods defined for a given generic function.  
[selectMethod](#) for getting the definition of a specific method.  
[density,flowClust-method](#) in the `flowClust` package for the method defined for `flowClust` objects.  
[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
density
showMethods("density")
selectMethod("density", "ANY") # the default method
```

---

duplicated	<i>Determine duplicate elements</i>
------------	-------------------------------------

---

**Description**

Determines which elements of a vector-like or data-frame-like R object are duplicates of elements with smaller subscripts, and returns a logical vector indicating which elements (rows) are duplicates.

NOTE: This man page is for the `duplicated` and `anyDuplicated` S4 generic functions defined in the `BiocGenerics` package. See `?base::duplicated` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like or data-frame-like) not supported by the default method.

**Usage**

```
duplicated(x, incomparables=FALSE, ...)
anyDuplicated(x, incomparables=FALSE, ...)
```

**Arguments**

`x` A vector-like or data-frame-like R object.  
`incomparables, ...`  
 See `?base::duplicated` for a description of these arguments.

**Value**

The default `duplicated` method (see `?base::duplicated`) returns a logical vector of length `N` where `N` is:

- `length(x)` when `x` is a vector;
- `nrow(x)` when `x` is a data frame.

Specific `duplicated` methods defined in other Bioconductor packages must also return a logical vector of the same length as `x` when `x` is a vector-like object, and a logical vector with one element for each row when `x` is a data-frame-like object.

The default `anyDuplicated` method (see `?base::duplicated`) returns a single non-negative integer and so must the specific `anyDuplicated` methods defined in other Bioconductor packages.

`anyDuplicated` should always behave consistently with `duplicated`.

**See Also**

`base::duplicated` for the default `duplicated` and `anyDuplicated` methods.  
`showMethods` for displaying a summary of the methods defined for a given generic function.  
`selectMethod` for getting the definition of a specific method.  
`duplicated`, `Ranges-method` in the `IRanges` package for the method defined for `Ranges` objects.  
`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
duplicated
showMethods("duplicated")
selectMethod("duplicated", "ANY") # the default method

anyDuplicated
showMethods("anyDuplicated")
selectMethod("anyDuplicated", "ANY") # the default method
```

---

eval

*Evaluate an (unevaluated) expression*


---

**Description**

`eval` evaluates an R expression in a specified environment.

NOTE: This man page is for the `eval` S4 generic function defined in the `BiocGenerics` package. See `?base::eval` for the default method (defined in the `base` package). Bioconductor packages can define specific methods for objects not supported by the default method.

**Usage**

```
eval(expr, envir=parent.frame(),
      enclos=if (is.list(envir) || is.pairlist(envir))
                parent.frame() else baseenv())
```

**Arguments**

<code>expr</code>	An object to be evaluated. May be any object supported by the default method (see <code>?base::eval</code> ) or by the additional methods defined in Bioconductor packages.
<code>envir</code>	The <i>environment</i> in which <code>expr</code> is to be evaluated. May be any object supported by the default method (see <code>?base::eval</code> ) or by the additional methods defined in Bioconductor packages.
<code>enclos</code>	See <code>?base::eval</code> for a description of this argument.

**Value**

See `?base::eval` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

**See Also**

`base::eval` for the default eval method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`eval`, `expression`, `List-method` in the `IRanges` package for the method defined for when the `expr` and `envir` arguments are `expression` and `List` objects, respectively.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
eval # note the dispatch on 'expr' and 'envir' args only
showMethods("eval")
selectMethod("eval", c("ANY", "ANY")) # the default method
```

---

 Extremes

*Maxima and minima*


---

**Description**

`pmax`, `pmin`, `pmax.int` and `pmin.int` return the parallel maxima and minima of the input values.

NOTE: This man page is for the `pmax`, `pmin`, `pmax.int` and `pmin.int` S4 generic functions defined in the `BiocGenerics` package. See `?base::pmax` for the default methods (defined in the `base` package). Bioconductor packages can define specific methods for objects (typically vector-like or matrix-like) not supported by the default methods.

**Usage**

```
pmax(..., na.rm=FALSE)
pmin(..., na.rm=FALSE)

pmax.int(..., na.rm=FALSE)
pmin.int(..., na.rm=FALSE)
```

**Arguments**

`...` One or more vector-like or matrix-like R objects.

`na.rm` See `?base::pmax` for a description of this argument.

**Value**

See `?base::pmax` for the value returned by the default methods.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input objects.

**See Also**

`base::pmax` for the default `pmax`, `pmin`, `pmax.int` and `pmin.int` methods.  
[showMethods](#) for displaying a summary of the methods defined for a given generic function.  
[selectMethod](#) for getting the definition of a specific method.  
[pmax,Rle-method](#) in the `IRanges` package for the `pmax` method defined for `Rle` objects.  
[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
pmax
showMethods("pmax")
selectMethod("pmax", "ANY") # the default method

pmin
showMethods("pmin")
selectMethod("pmin", "ANY") # the default method

pmax.int
showMethods("pmax.int")
selectMethod("pmax.int", "ANY") # the default method

pmin.int
showMethods("pmin.int")
selectMethod("pmin.int", "ANY") # the default method
```

**Description**

`Reduce` uses a binary function to successively combine the elements of a given list-like or vector-like R object and a possibly given initial value. `Filter` extracts the elements of a list-like or vector-like R object for which a predicate (logical) function gives true. `Find` and `Position` give the first or last such element and its position in the object, respectively. `Map` applies a function to the corresponding elements of given list-like or vector-like R objects.

NOTE: This man page is for the `Reduce`, `Filter`, `Find`, `Map` and `Position` S4 generic functions defined in the `BiocGenerics` package. See `?base::Reduce` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically list-like or vector-like) not supported by the default methods.

**Usage**

```
Reduce(f, x, init, right=FALSE, accumulate=FALSE)
Filter(f, x)
Find(f, x, right=FALSE, nomatch=NULL)
Map(f, ...)
Position(f, x, right=FALSE, nomatch=NA_integer_)
```

**Arguments**

f, init, right, accumulate, nomatch  
 See `?base::Reduce` for a description of these arguments.

x  
 A list-like or vector-like R object.

...  
 One or more list-like or vector-like R objects.

**Value**

See `?base::Reduce` for the value returned by the default methods.  
 Specific Reduce methods defined in other Bioconductor packages should also return a single integer.

**See Also**

`base::Reduce` for the default Reduce, Filter, Find, Map and Position methods.  
[showMethods](#) for displaying a summary of the methods defined for a given generic function.  
[selectMethod](#) for getting the definition of a specific method.  
[Reduce,List-method](#) in the IRanges package for the Reduce method defined for [List](#) objects.  
[BiocGenerics](#) for a summary of all the generics defined in the BiocGenerics package.

**Examples**

```
Reduce # note the dispatch on the 'x' arg only
showMethods("Reduce")
selectMethod("Reduce", "ANY") # the default method

Filter # note the dispatch on the 'x' arg only
showMethods("Filter")
selectMethod("Filter", "ANY") # the default method

Find # note the dispatch on the 'x' arg only
showMethods("Find")
selectMethod("Find", "ANY") # the default method

Map # note the dispatch on the '...' arg only
showMethods("Map")
selectMethod("Map", "ANY") # the default method

Position # note the dispatch on the 'x' arg only
showMethods("Position")
selectMethod("Position", "ANY") # the default method
```

---

get

*Return the value of a named object*


---

**Description**

Search for an R object with a given name and return it.

NOTE: This man page is for the `get` and `mget` S4 generic functions defined in the `BiocGenerics` package. See `?base::get` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (list-like or environment-like) not supported by the default methods.

**Usage**

```
get(x, pos=-1, envir=as.environment(pos), mode="any", inherits=TRUE)
mget(x, envir, mode="any",
     ifnotfound=list(function(x)
                       stop(paste0("value for '", x, "' not found"),
                             call.=FALSE)),
     inherits=FALSE)
```

**Arguments**

`x` For `get`: A variable name (or, more generally speaking, a *key*), given as a single string.  
 For `mget`: A vector of variable names (or *keys*).

`envir` Where to look for the key(s). Typically a list-like or environment-like object.

`pos`, `mode`, `inherits`, `ifnotfound`  
 See `?base::get` for a description of these arguments.

**Details**

See `?base::get` for details about the default methods.

**Value**

For `get`: The value corresponding to the specified key.

For `mget`: The list of values corresponding to the specified keys. The returned list must have one element per key, and in the same order as in `x`.

See `?base::get` for the value returned by the default methods.

**See Also**

`base::get` for the default `get` and `mget` methods.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`get,ANY,AnnDbBimap,missing-method` in the `AnnotationDbi` package for the `get` method defined for `AnnDbBimap` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
get # note the dispatch on the 'x', 'pos' and 'envir' args only
showMethods("get")
selectMethod("get", c("ANY", "ANY", "ANY")) # the default method

mget # note the dispatch on the 'x' and 'envir' args only
showMethods("mget")
selectMethod("mget", c("ANY", "ANY")) # the default method
```

---

image	<i>Display a color image</i>
-------	------------------------------

---

## Description

Creates a grid of colored or gray-scale rectangles with colors corresponding to the values in z. This can be used to display three-dimensional or spatial data aka *images*.

NOTE: This man page is for the `image` S4 generic function defined in the `BiocGenerics` package. See `?graphics::image` for the default method (defined in the `graphics` package). Bioconductor packages can define specific methods for objects not supported by the default method.

## Usage

```
image(x, ...)
```

## Arguments

x, ... See `?graphics::image`.

## Details

See `?graphics::image` for the details.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

## See Also

`graphics::image` for the default `image` method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`image,FeatureSet-method` in the `oligo` package for the method defined for `FeatureSet` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
image
showMethods("image")
selectMethod("image", "ANY") # the default method
```

lapply

*Apply a function over a list-like or vector-like R object***Description**

lapply returns a list of the same length as X, each element of which is the result of applying FUN to the corresponding element of X.

sapply is a user-friendly version and wrapper of lapply by default returning a vector, matrix or, if simplify="array", an array if appropriate, by applying simplify2array(). sapply(x, f, simplify=FALSE, USE.NAMES) is the same as lapply(x, f).

NOTE: This man page is for the lapply and sapply S4 generic functions defined in the BiocGenerics package. See `?base::lapply` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically list-like or vector-like) not supported by the default methods.

**Usage**

```
lapply(X, FUN, ...)
sapply(X, FUN, ..., simplify=TRUE, USE.NAMES=TRUE)
```

**Arguments**

X                    A list-like or vector-like R object.  
 FUN, ..., simplify, USE.NAMES  
                     See `?base::lapply` for a description of these arguments.

**Value**

See `?base::lapply` for the value returned by the default methods.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default methods. In particular, lapply and sapply(simplify=FALSE) should always return a list.

**See Also**

`base::lapply` for the default lapply and sapply methods.  
[showMethods](#) for displaying a summary of the methods defined for a given generic function.  
[selectMethod](#) for getting the definition of a specific method.  
[lapply,List-method](#) in the IRanges package for the lapply method defined for [List](#) objects.  
[BiocGenerics](#) for a summary of all the generics defined in the BiocGenerics package.

**Examples**

```
lapply # note the dispatch on the 'X' arg only
showMethods("lapply")
selectMethod("lapply", "ANY") # the default method

sapply # note the dispatch on the 'X' arg only
showMethods("sapply")
selectMethod("sapply", "ANY") # the default method
```



---

`mapply`*Apply a function to multiple list-like or vector-like arguments*

---

## Description

`mapply` is a multivariate version of [sapply](#). `mapply` applies FUN to the first elements of each ... argument, the second elements, the third elements, and so on. Arguments are recycled if necessary.

NOTE: This man page is for the `mapply` S4 generic function defined in the `BiocGenerics` package. See `?base::mapply` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects (typically list-like or vector-like) not supported by the default methods.

## Usage

```
mapply(FUN, ..., MoreArgs=NULL, SIMPLIFY=TRUE, USE.NAMES=TRUE)
```

## Arguments

FUN, MoreArgs, SIMPLIFY, USE.NAMES

See `?base::mapply` for a description of these arguments.

... One or more list-like or vector-like R objects of strictly positive length, or all of zero length.

## Value

See `?base::mapply` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

## See Also

`base::mapply` for the default `mapply` method.

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[mapply.List-method](#) in the `IRanges` package for the `mapply` method defined for `List` objects.

[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
mapply # note the dispatch on the '...' arg only
showMethods("mapply")
selectMethod("mapply", "ANY") # the default method
```

---

nrow

*The number of rows/columns of an array-like object*

---

## Description

Return the number of rows or columns present in an array-like R object.

NOTE: This man page is for the `nrow`, `ncol`, `NROW` and `NCOL` S4 generic functions defined in the `BiocGenerics` package. See `?base::nrow` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically matrix- or array-like) not supported by the default methods.

## Usage

```
nrow(x)
ncol(x)
NROW(x)
NCOL(x)
```

## Arguments

`x` A matrix- or array-like R object.

## Value

A single integer or `NULL`.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default methods.

## See Also

`base::nrow` for the default `nrow`, `ncol`, `NROW` and `NCOL` methods.

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[nrow,DataFrame-method](#) in the `IRanges` package for the `nrow` method defined for `DataFrame` objects.

[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
nrow
showMethods("nrow")
selectMethod("nrow", "ANY") # the default method

ncol
showMethods("ncol")
selectMethod("ncol", "ANY") # the default method

NROW
showMethods("NROW")
selectMethod("NROW", "ANY") # the default method
```

```
NCOL
showMethods("NCOL")
selectMethod("NCOL", "ANY") # the default method
```

---

order	<i>Ordering permutation</i>
-------	-----------------------------

---

## Description

`order` returns a permutation which rearranges its first argument into ascending or descending order, breaking ties by further arguments.

NOTE: This man page is for the `order` S4 generic function defined in the `BiocGenerics` package. See `?base::order` for the default method (defined in the `base` package). Bioconductor packages can define specific methods for objects (typically vector-like) not supported by the default method.

## Usage

```
order(..., na.last=TRUE, decreasing=FALSE)
```

## Arguments

`...` One or more vector-like R objects, all of the same length.  
`na.last, decreasing`  
 See `?base::order` for a description of these arguments.

## Value

The default method (see `?base::order`) returns an integer vector of length `N` where `N` is the common length of the input objects. This integer vector represents a permutation of `N` elements and can be used to rearrange the first argument in `...` into ascending or descending order (by subsetting it).

Specific methods defined in other Bioconductor packages must also return an integer vector representing a permutation of `N` elements.

## Note

TO DEVELOPPERS: Here are 2 common pitfalls when implementing an `order` method:

- `order(x, decreasing=TRUE)` is *not* equivalent to `rev(order(x))`;
- It should be made "stable" for consistent behavior across platforms and consistency with `base::order()`. Note that C `qsort()` is *not* "stable" so `order` methods that use `qsort()` at the C-level need to ultimately break ties by position (this is generally done by adding a little extra code at the end of the comparison function used in the calls to `qsort()`).

## See Also

`base::order` for the default order method.  
[showMethods](#) for displaying a summary of the methods defined for a given generic function.  
[selectMethod](#) for getting the definition of a specific method.  
[order,Ranges-method](#) in the `IRanges` package for the method defined for `Ranges` objects.  
[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
order
showMethods("order")
selectMethod("order", "ANY") # the default method
```

---

paste	<i>Concatenate strings</i>
-------	----------------------------

---

## Description

paste concatenates vectors of strings or vector-like R objects containing strings.

NOTE: This man page is for the paste S4 generic function defined in the BiocGenerics package. See `?base::paste` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like objects containing strings) not supported by the default method.

## Usage

```
paste(..., sep=" ", collapse=NULL)
```

## Arguments

... One or more vector-like R objects containing strings.  
sep, collapse See `?base::paste` for a description of these arguments.

## Value

See `?base::paste` for the value returned by the default method.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input objects.

## See Also

`base::paste` for the default paste method.  
`showMethods` for displaying a summary of the methods defined for a given generic function.  
`selectMethod` for getting the definition of a specific method.  
`paste,Rle-method` in the IRanges package for the method defined for `Rle` objects.  
`BiocGenerics` for a summary of all the generics defined in the BiocGenerics package.

## Examples

```
paste
showMethods("paste")
selectMethod("paste", "ANY") # the default method
```

---

`rep`*Replicate elements of a vector-like R object*

---

## Description

`rep.int` replicates the elements in `x`.

NOTE: This man page is for the `rep.int` S4 generic function defined in the `BiocGenerics` package. See `?base::rep.int` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like) not supported by the default method.

## Usage

```
## Unlike the standard rep.int() function defined in base (default method),
## the generic function described here have a '...' argument (instead of
## 'times').
rep.int(x, ...)
```

## Arguments

<code>x</code>	R object (typically vector-like).
<code>...</code>	Additional arguments, for use in specific <code>rep.int</code> methods.

## Value

See `?base::rep.int` for the value returned by the default method.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input object.

## See Also

`base::rep.int` for the default `rep.int`, `intersect`, and `setdiff` methods.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`rep.int,Rle-method` in the `IRanges` package for the method defined for `Rle` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
rep.int
showMethods("rep.int")
selectMethod("rep.int", "ANY") # the default method
```

---

`residuals`*Extract model residuals*

---

### Description

`residuals` is a generic function which extracts model residuals from objects returned by modeling functions.

NOTE: This man page is for the `residuals` S4 generic function defined in the `BiocGenerics` package. See `?stats::residuals` for the default method (defined in the `stats` package). Bioconductor packages can define specific methods for objects not supported by the default method.

### Usage

```
residuals(object, ...)
```

### Arguments

`object, ...` See `?stats::residuals`.

### Value

Residuals extracted from the object `object`.

### See Also

`stats::residuals` for the default `residuals` method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`residuals,PLMset-method` in the `affyPLM` package for the method defined for `PLMset` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

### Examples

```
residuals
showMethods("residuals")
selectMethod("residuals", "ANY") # the default method
```

---

`row+colnames`*Row and column names*

---

### Description

Retrieve the row or column names of a matrix-like R object.

NOTE: This man page is for the `rownames` and `colnames` S4 generic functions defined in the `BiocGenerics` package. See `?base::rownames` for the default methods (defined in the `base` package). Bioconductor packages can define specific methods for objects (typically matrix-like) not supported by the default methods.

## Usage

```
rownames(x, do.NULL=TRUE, prefix="row")
colnames(x, do.NULL=TRUE, prefix="col")
```

## Arguments

`x` A matrix-like R object.  
`do.NULL`, `prefix`  
See `?base::rownames` for a description of these arguments.

## Value

NULL or a character vector of length `nrow(x)` for `rownames` and `ncol(x)` for `colnames(x)`. See `?base::rownames` for more information about the default methods.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default methods.

## See Also

`base::rownames` for the default `rownames` and `colnames` methods.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`rownames,DataFrame-method` in the `IRanges` package for the `rownames` method defined for `DataFrame` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
rownames # note the dispatch on the 'x' arg only
showMethods("rownames")
selectMethod("rownames", "ANY") # the default method

colnames # note the dispatch on the 'x' arg only
showMethods("colnames")
selectMethod("colnames", "ANY") # the default method
```

---

sets

*Set operations*

---

## Description

Performs *set* union, intersection and (asymmetric!) difference on two vector-like R objects.

NOTE: This man page is for the `union`, `intersect` and `setdiff` S4 generic functions defined in the `BiocGenerics` package. See `?base::union` for the default methods (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like) not supported by the default methods.

## Usage

```
union(x, y, ...)  
intersect(x, y, ...)  
setdiff(x, y, ...)
```

## Arguments

<code>x, y</code>	R objects of the same class (typically a vector-like class).
<code>...</code>	Additional arguments, for use in specific methods.

## Value

See `?base::union` for the value returned by the default methods.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input objects.

## Note

The default methods (defined in the base package) only take 2 arguments. We've added the `...` argument to the generic functions defined in the `BiocGenerics` package so they can be called with an arbitrary number of effective arguments. For `union` or `intersect`, this typically allows Bioconductor packages to define methods that compute the union or intersection of more than 2 objects. However, for `setdiff`, which is conceptually a binary operation, this typically allows methods to add extra arguments for controlling/altering the behavior of the operation. Like for example the `ignore.strand` argument supported by the `setdiff` method for `GRanges` objects (defined in the `GenomicRanges` package). (Note that the `union` and `intersect` methods for those objects also support the `ignore.strand` argument.)

## See Also

`base::union` for the default `union`, `intersect`, and `setdiff` methods.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`union,GRanges,GRanges-method` in the `GenomicRanges` package for the `union` method defined for `GRanges` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
union  
showMethods("union")  
selectMethod("union", c("ANY", "ANY")) # the default method  
  
intersect  
showMethods("intersect")  
selectMethod("intersect", c("ANY", "ANY")) # the default method  
  
setdiff  
showMethods("setdiff")  
selectMethod("setdiff", c("ANY", "ANY")) # the default method
```



---

strand	<i>Accessing strand information</i>
--------	-------------------------------------

---

**Description**

Get or set the strand information contained in an object.

**Usage**

```
strand(x, ...)  
strand(x, ...) <- value
```

**Arguments**

x	An object containing strand information.
...	Additional arguments, for use in specific methods.
value	The strand information to set on x.

**Note**

All the `strand` methods defined in the `GenomicRanges` package use the same set of 3 values (levels) to specify the strand of a genomic location: `+`, `-`, and `*`. `*` is used when the exact strand of the location is unknown, or irrelevant, or when the "feature" at that location belongs to both strands.

**See Also**

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[strand,GRanges-method](#) in the `GenomicRanges` package for the method defined for `GRanges` objects.

[BiocGenerics](#) for a summary of all the generics defined in the `BiocGenerics` package.

**Examples**

```
strand  
showMethods("strand")  
  
library(GenomicRanges)  
showMethods("strand")  
selectMethod("strand", "missing")  
strand()
```

---

table	<i>Cross tabulation and table creation</i>
-------	--

---

### Description

table uses the cross-classifying factors to build a contingency table of the counts at each combination of factor levels.

NOTE: This man page is for the table S4 generic function defined in the BiocGenerics package. See `?base::table` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects not supported by the default method.

### Usage

```
table(...)
```

### Arguments

... One or more R objects which can be interpreted as factors (including character strings), or a list (or data frame) whose components can be so interpreted.

### Value

See `?base::table` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should also return the type of object returned by the default method.

### See Also

`base::table` for the default table method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`table,Rle-method` in the IRanges package for the method defined for `Rle` objects.

`BiocGenerics` for a summary of all the generics defined in the BiocGenerics package.

### Examples

```
table
showMethods("table")
selectMethod("table", "ANY") # the default method
```

---

`tapply`*Apply a function over a ragged array*

---

## Description

`tapply` applies a function to each cell of a ragged array, that is to each (non-empty) group of values given by a unique combination of the levels of certain factors.

NOTE: This man page is for the `tapply` S4 generic function defined in the `BiocGenerics` package. See `?base::tapply` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects (typically list-like or vector-like) not supported by the default methods.

## Usage

```
tapply(X, INDEX, FUN=NULL, ..., simplify=TRUE)
```

## Arguments

`X` A list-like or vector-like R object.

`INDEX, FUN, ..., simplify`

See `?base::tapply` for a description of these arguments.

## Value

See `?base::tapply` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

## See Also

`base::tapply` for the default `tapply` method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`tapply,Vector-method` in the `IRanges` package for the `tapply` method defined for `Vector` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
tapply # note the dispatch on the 'X' arg only
showMethods("tapply")
selectMethod("tapply", "ANY") # the default method
```

---

`unique`*Extract unique elements*

---

## Description

`unique` returns an object of the same class as `x` (typically a vector-like, data-frame-like, or array-like R object) but with duplicate elements/rows removed.

NOTE: This man page is for the `unique` S4 generic function defined in the `BiocGenerics` package. See `?base::unique` for the default method (defined in the base package). Bioconductor packages can define specific methods for objects (typically vector-like or data-frame-like) not supported by the default method.

## Usage

```
unique(x, incomparables=FALSE, ...)
```

## Arguments

`x` A vector-like, data-frame-like, or array-like R object.  
`incomparables, ...`  
See `?base::unique` for a description of these arguments.

## Value

See `?base::unique` for the value returned by the default method.

Specific methods defined in other Bioconductor packages will typically return an object of the same class as the input object.

`unique` should always behave consistently with `BiocGenerics::duplicated`.

## See Also

`base::unique` for the default `unique` method.

`BiocGenerics::duplicated` for determining duplicate elements.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`unique,Ranges-method` in the `IRanges` package for the method defined for `Ranges` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
unique
showMethods("unique")
selectMethod("unique", "ANY") # the default method
```

---

updateObject	<i>Update an object to its current class definition</i>
--------------	---

---

### Description

updateObject is a generic function that returns an instance of object updated to its current class definition.

### Usage

```
updateObject(object, ..., verbose=FALSE)
```

```
## Related utilities:
```

```
updateObjectFromSlots(object, objclass=class(object), ..., verbose=FALSE)
getObjectSlots(object)
```

### Arguments

object	Object to be updated for updateObject and updateObjectFromSlots. Object for slot information to be extracted from for getObjectSlots.
...	Additional arguments, for use in specific updateObject methods.
verbose	TRUE or FALSE, indicating whether information about the update should be reported. Use <a href="#">message</a> to report this information.
objclass	Optional character string naming the class of the object to be created.

### Details

Updating objects is primarily useful when an object has been serialized (e.g., stored to disk) for some time (e.g., months), and the class definition has in the mean time changed. Because of the changed class definition, the serialized instance is no longer valid.

updateObject requires that the class of the returned object be the same as the class of the argument object, and that the object is valid (see [validObject](#)). By default, updateObject has the following behaviors:

updateObject(ANY, ..., verbose=FALSE) By default, updateObject uses heuristic methods to determine whether the object should be the ‘new’ S4 type (introduced in R 2.4.0), but is not. If the heuristics indicate an update is required, the updateObjectFromSlots function tries to update the object. The default method returns the original S4 object or the successfully updated object, or issues an error if an update is required but not possible. The optional named argument verbose causes a message to be printed describing the action. Arguments ... are passed to updateObjectFromSlots.

updateObject(list, ..., verbose=FALSE) Visit each element in list, applying updateObject(list[[elt]], ...)

updateObject(environment, ..., verbose=FALSE) Visit each element in environment, applying updateObject(environment[[elt]], ..., verbose=verbose)

updateObjectFromSlots(object, objclass=class(object), ..., verbose=...) is a utility function that identifies the intersection of slots defined in the object instance and objclass definition. The corresponding elements in object are then updated (with updateObject(elt, ..., verbose=...) and used as arguments to a call to new(class, ...), with ... replaced by slots from the original

object. If this fails, `updateObjectFromSlots` then tries `new(class)` and assigns slots of object to the newly created instance.

`getObjectSlots(object)` extracts the slot names and contents from object. This is useful when object was created by a class definition that is no longer current, and hence the contents of object cannot be determined by accessing known slots.

### Value

`updateObject` returns a valid instance of object.

`updateObjectFromSlots` returns an instance of class `objclass`.

`getObjectSlots` returns a list of named elements, with each element corresponding to a slot in object.

### See Also

[updateObjectTo](#) in the Biobase package for updating an object to the class definition of a template (might be useful for updating a virtual superclass).

[validObject](#) for testing the validity of an object.

[showMethods](#) for displaying a summary of the methods defined for a given generic function.

[selectMethod](#) for getting the definition of a specific method.

[BiocGenerics](#) for a summary of all the generics defined in the BiocGenerics package.

### Examples

```
updateObject
showMethods("updateObject")
selectMethod("updateObject", "ANY") # the default method

library(Biobase)
## update object, same class
data(sample.ExpressionSet)
obj <- updateObject(sample.ExpressionSet)

setClass("UpdtA", representation(x="numeric"), contains="data.frame")
setMethod("updateObject", "UpdtA",
  function(object, ..., verbose=FALSE)
  {
    if (verbose)
      message("updateObject object = 'A'")
    object <- callNextMethod()
    object@x <- -object@x
    object
  }
)

a <- new("UpdtA", x=1:10)
## See steps involved
updateObject(a)

removeMethod("updateObject", "UpdtA")
removeClass("UpdtA")
```

---

weights	<i>Extract model weights</i>
---------	------------------------------

---

## Description

`weights` is a generic function which extracts fitting weights from objects returned by modeling functions.

NOTE: This man page is for the `weights` S4 generic function defined in the `BiocGenerics` package. See `?stats::weights` for the default method (defined in the `stats` package). Bioconductor packages can define specific methods for objects not supported by the default method.

## Usage

```
weights(object, ...)
```

## Arguments

`object, ...` See `?stats::weights`.

## Value

Weights extracted from the object `object`.

See `?stats::weights` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should behave as consistently as possible with the default method.

## See Also

`stats::weights` for the default `weights` method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`weights, PLMset-method` in the `affyPLM` package for the method defined for `PLMset` objects.

`BiocGenerics` for a summary of all the generics defined in the `BiocGenerics` package.

## Examples

```
weights
showMethods("weights")
selectMethod("weights", "ANY") # the default method
```

---

xtabs

*Cross tabulation*

---

## Description

xtabs creates a contingency table (optionally a sparse matrix) from cross-classifying factors, usually contained in a data-frame-like object, using a formula interface.

NOTE: This man page is for the xtabs S4 generic function defined in the BiocGenerics package. See `?stats::xtabs` for the default method (defined in the stats package). Bioconductor packages can define specific methods for objects not supported by the default method.

## Usage

```
xtabs(formula=~., data=parent.frame(), subset, sparse=FALSE,
      na.action, exclude=c(NA, NaN), drop.unused.levels=FALSE)
```

## Arguments

formula, subset, sparse, na.action, exclude, drop.unused.levels  
See `?stats::xtabs` for a description of these arguments.

data            A data-frame-like R object.

## Value

See `?stats::xtabs` for the value returned by the default method.

Specific methods defined in other Bioconductor packages should also return the type of object returned by the default method.

## See Also

`stats::xtabs` for the default xtabs method.

`showMethods` for displaying a summary of the methods defined for a given generic function.

`selectMethod` for getting the definition of a specific method.

`xtabs,DataTable-method` in the IRanges package for the method defined for `DataTable` objects.

`BiocGenerics` for a summary of all the generics defined in the BiocGenerics package.

## Examples

```
xtabs # note the dispatch on the 'data' arg only
showMethods("xtabs")
selectMethod("xtabs", "ANY") # the default method
```



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