

# Package ‘squarebrackets’

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**Type** Package

**Title** Subset Methods as Alternatives to the Square Brackets Operators for Programming

**Version** 0.0.0.9

**Description** Provides subset methods

(supporting both atomic and recursive S3 classes)

that may be more convenient alternatives to the `[` and `[<-` operators, whilst maintaining similar performance.

Some nice properties of these methods include, but are not limited to, the following.

1) The `[` and `[<-` operators use different rule-sets for different data.frame-like types (data.frames, tibbles, data.tables, tibbles, etc.).

The 'squarebrackets' methods use the same rule-sets for the different data.frame-like types.

2) Performing dimensional subset operations on an array using `[` and `[<-`, requires a-priori knowledge of the number of dimensions the array has.

The 'squarebrackets' methods work on any arbitrary dimensions without requiring such prior knowledge.

3) When selecting names with the `[` and `[<-` operators, only the first occurrence of the names are selected in case of duplicate names.

The 'squarebrackets' methods always perform on all names in case of duplicates, not just the first.

4) The `[[` and `[[<-` operators

allow operating on a recursive subset of a nested list.

But these only operate on a single recursive subset,

and are not vectorized for multiple recursive subsets of a nested list at once.

'squarebrackets' provides a way to reshape a nested list

into a 2D recursive array of lists,

thereby allowing vectorized operations on recursive subsets of such a nested list.

5) The `[<-` operator only supports copy-on-modify semantics for most classes.

The 'squarebrackets' methods provides explicit pass-by-reference and pass-by-value semantics, whilst still respecting things like binding-locks and mutability rules.

6) 'squarebrackets' supports index-less sub-set operations,

which is faster and more memory efficient than sub-set operations using the `[` and `[<-` operators.

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aaa0\_squarebrackets\_help

*squarebrackets: Subset Methods as Alternatives to the Square Brackets Operators for Programming*


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## Description

squarebrackets: Subset Methods as Alternatives to the Square Brackets Operators for Programming

## Goal & Properties

Among programming languages, 'R' has perhaps one of the most flexible and comprehensive sub-setting functionality, provided by the square brackets operators (`[]`, `[]<-`). But in some situations the square brackets operators are occasionally less than optimally convenient (see [squarebrackets\\_inconveniences](#)).

The Goal of the 'squarebrackets' package is not to replace the square-brackets operators, but to provide **alternative** sub-setting methods and functions, to be used in situations where the square bracket operators are inconvenient.

These alternative sub-setting methods and functions have the following properties:

- **Programmatically friendly:**
  - Unlike base `[]`, it's not required to know the number of dimensions of an array a-priori, to perform subset-operations on an array.
  - Missing arguments can be filled with `NULL`, instead of using dark magic like `base::quote(expr = )`.
  - No Non-standard evaluation.
  - Functions are pipe-friendly.
  - No (silent) vector recycling.
  - Extracting and removing subsets uses the same syntax.
- **Class consistent:**
  - sub-setting of multi-dimensional objects by specifying dimensions (i.e. rows, columns, ...) use `drop = FALSE`.  
So matrix in, matrix out.

- The methods deliver the same results for `data.frames`, `data.tables`, `tibbles`, and `tidytables`. No longer does one have to re-learn the different brackets-based sub-setting rules for different types of `data.frame`-like objects. Powered by the subclass agnostic 'C'-code from 'collapse' and 'data.table'.
- **Explicit copy semantics:**
  - Sub-set operations that change its memory allocations, always return a modified (partial) copy of the object.
  - For sub-set operations that just change values in-place (similar to the `[<-` and `[[<-` methods) the user can choose a method that modifies the object by **reference**, or choose a method that returns a **(partial) copy**.
- **Careful handling of names:**
  - Sub-setting an object by index names returns ALL matches with the given names, not just the first.
  - `Data.frame`-like objects (see supported classes below) are forced to have unique column names.
  - Sub-setting arrays using `x[indx1, indx2, etc.]` will drop `names(x)`. The methods from 'squarebrackets' will not drop `names(x)`.
- **Concise function and argument names.**
- **Performance aware:**  
Despite the many checks performed, the functions are kept reasonably speedy, through the use of the 'Rcpp', 'collapse', and 'data.table' R-packages.

## Supported Classes

'squarebrackets' only supports the most common S3 classes, and only those that primarily use square brackets for sub-setting (hence the name of the package).

Supported immutable classes:

`atomic`, `list`, `data.frame` (including `tibble`, `sf-data.frame`, and `sf-tibble`).

Supported mutable classes:

[mutable\\_atomic](#), `data.table` (including `tidytable`, `sf-data.table`, and `sf-tidytable`).

Key-value storages, such as environments, and the various classes of the 'collections' package, are not supported.

## Methods

The main focus of this package is on its generic methods and dimensional binding implementations.

Generic methods for atomic objects start with `sb_`.

Generic methods for recursive objects (`list`, `data.frame`, etc.) start with `sb2_`.

The binding implementations for atomic dimensional objects (atomic arrays) start with `bind_`.

The binding implementations for recursive dimensional objects (recursive arrays, `data.frames`) start with `bind2_`.

There is also the somewhat separate [idx](#) method, which works on both recursive and non-recursive

objects.

And finally there are the `slice_` methods, which (currently) only work on atomic vectors.

## ACCESSOR METHODS

Methods to access subsets (i.e. extract selection, or extract all except selection):

- [sb\\_x](#), [sb2\\_x](#): extract, exchange, or duplicate subsets.
- [sb\\_rm](#), [sb2\\_rm](#): un-select/remove subsets.
- [sb2\\_rec](#): access recursive subsets of lists.
- [slice\\_x](#), [slice\\_rm](#): efficiently extract or un-select/remove subset from a (long) vector.

## MODIFICATION METHODS

Methods to modify subsets:

- [idx](#): translate given indices/subscripts, for the purpose of copy-on-modify substitution.
- [sb2\\_recin](#): replace, transform, remove, or add recursive subsets to a list, through R's default Copy-On-Modify semantics.
- [sb\\_mod](#), [sb2\\_mod](#): return a **(partial) copy** of an object with modified (transformed or replaced) subsets.
- [sb\\_set](#), [sb2\\_set](#): modify (transform or replace) subsets of a [mutable object](#) using [pass-by-reference semantics](#).
- [slice\\_set](#): efficiently modify a (long) vector subset using [pass-by-reference semantics](#).

## EXTENDING METHODS

Methods to extend or re-arrange an object beyond its current size:

- [bind\\_](#), [bind2\\_](#): implementations for binding dimensional objects.
- [sb\\_x](#), [sb2\\_x](#): extract, exchange, or duplicate subsets.
- [sb2\\_recin](#): replace, transform, remove, or add recursive subsets to a list, through R's default Copy-On-Modify semantics.

So for example, use `sb_rm()` to remove subsets from atomic arrays, and use `sb2_rm()` to remove subsets from recursive arrays.

See [squarebrackets\\_method\\_dispatch](#) for more information on how 'squarebrackets' uses its S3 Method dispatch.

## Functions

### SPECIALIZED FUNCTIONS

Additional specialized sub-setting functions are provided:

- `lst_untree`: unnest tree-like nested list into a recursive array, to make vectorized sub-setting on recursive subsets of the list easier.
- The `dt_`-functions to programmatically perform `data.table`-specific `[-`operations, with the security measures provided by the 'squarebrackets' package.
- `setapply`: apply functions over mutable matrix margins using [pass-by-reference semantics](#).
- `ma_setv`: Find & Replace values in `mutable_atomic` objects using [pass-by-reference semantics](#).

This is considerably faster and more memory efficient than using `sb_set` for this.

### HELPER FUNCTIONS

A couple of convenience functions, and helper functions for creating ranges, sequences, and indices (often needed in sub-setting) are provided:

- `currentBindings`: list or lock all currently existing bindings that share the same address as the input variable.
- `n`: Nested version of `c`, and short-hand for `list`.
- `ndims`: Get the number of dimensions of an object.
- `sub2coord`, `coord2ind`: Convert subscripts (array indices) to coordinates, coordinates to flat indices, and vice-versa.
- `match_all`: Find all matches, of one vector in another, taking into account the order and any duplicate values of both vectors.
- Computing indices:
  - `idx_r` to compute an integer index range.
  - `idx_by` to compute grouped indices.
  - `idx_ord_`-functions to compute ordered indices.

### DEVELOPER FUNCTIONS

And finally some developer functions for constructing indices.

These are also used internally by 'squarebrackets', and package authors can use these to create additional `sb_`/`sb2_` S3 methods, or even entirely new subset-related functions.

- `tci_` functions, for type-casting indices.
- `ci_` functions, for constructing indices.
- `indx_x` and `indx_rm`, for testing methods.

## Author(s)

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## References

The badges shown in the documentation of this R-package were made using the services of: <https://shields.io/>

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aaa1\_squarebrackets\_supported\_structures  
*Supported Structures*

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## Description

'squarebrackets' only supports the most common S3 objects, and only those that primarily use square brackets for sub-set operations (hence the name of the package).

One can generally divide the structures supported by 'squarebrackets' along 3 key properties:

- atomic vs recursive:  
Types logical, integer, double, complex, character, and raw are [atomic](#).  
Lists and data.frames are [recursive](#).
- dimensionality:  
Whether an object is a vector, matrix, array, or data.frame.
- mutability:  
Base R's S3 classes (except Environments) are generally immutable:  
Modifying the object will create a copy (called 'copy-on-modify').  
'squarebrackets' also supports data.tables and [mutable\\_atomic](#) objects, which are mutable:  
If desired, one can modify them without copy using [pass-by-reference semantics](#).

## Supported Structures

'squarebrackets' supports the following immutable structures:

- basic atomic vector classes  
(atomic vectors, matrices, and arrays).
- basic list classes  
(recursive vectors, matrices, and arrays)  
(note that lists are merely pointers to other objects, and these other objects may be of a different class and may even be mutable).
- [data.frame](#)  
(including the classes tibble, sf-data.frame and sf-tibble).

'squarebrackets' supports the following mutable structures:

- [mutable\\_atomic](#)  
(mutable\_atomic vectors, matrices, and arrays);
- [data.table](#)  
(including the classes tidytable, sf-data.table, and sf-tidytable).

What follows are details on the supported structures, and some explanation of some of the terminology.

## Details

### Atomic vs Recursive

The `sb_` methods and `bind_` implementations provided by 'squarebrackets' work on **atomic** (see [is.atomic](#)) objects.

The `sb2_` methods and `bind2_` implementations provided by 'squarebrackets' work on **recursive** (see [is.recursive](#)) objects.

The distinction is made between atomic and recursive methods, because R's S3 method dispatch only checks the class of an object.

So the S3 method dispatch makes no distinction, for example, between atomic matrices, and recursive matrices, despite them being completely different kinds of objects (except that they're both 2 dimensional objects).

See [squarebrackets\\_method\\_dispatch](#) for more details.

### Dimensionality

'squarebrackets' supports dimensionless or vector objects (i.e. `ndims == 0L`).

'squarebrackets' supports arrays (see [is.array](#) and [is.matrix](#)); note that a matrix is simply an array with 2 dimensions.

'squarebrackets' also supports data.frame-like objects (see [is.data.frame](#)).

Specifically, 'squarebrackets' supports a wide variety of data.frame classes:

`data.frame`, `data.table`, `tibble`, `tidytable`;

'squarebrackets' also supports their 'sf'-package compatible counter-parts:

`sf-data.frame`, `sf-data.table`, `sf-tibble`, `sf-tidytable`.

Dimensionless vectors and dimensional arrays are supported in both their atomic and recursive forms.

Data.frame-like objects, in contrast, **only** exist in the **recursive** form (and, as stated, are supported by 'squarebrackets').

Recursive vectors, recursive matrices, and recursive arrays, are collectively referred to as "lists" in the 'squarebrackets' documentation.

Note that the dimensionality of data.frame-like objects is not the same as the dimensionality of (recursive) arrays/matrices.

For any array/matrix `x`, it holds that `length(x) == prod(dim(x))`.

But for any data.frame `x`, it is the case that `length(x) == ncol(x)`.

### Mutable vs Immutable

Most S3 objects in base 'R' are immutable:

They have no explicit [pass-by-reference](#) semantics.

Environments do have [pass-by-reference](#) semantics, but they are not supported by 'squarebrackets'.

'squarebrackets' supports the mutable `data.table` class (and thus also `tidytable`, which inherits from `data.table`).

'squarebrackets' also includes a new class of mutable objects: [mutable\\_atomic](#) objects.

`mutable_atomic` objects are the same as atomic objects, except they are mutable (hence the name).

The supported immutable structures are:

Atomic and recursive vectors/matrices/arrays, data.frames, and tibbles.



All the functions in the 'squarebrackets' package with the word "set" in their name perform [pass-by-reference](#) modification, and thus only work on mutable structures.

All other functions work the same way for both mutable and immutable structures.

### Derived Atomic Vector

A special class of objects are the Derived Atomic Vector structures: structures that are derived from atomic objects, but behave differently.

For example:

Factors, datetime, POSIXct and so on are derived from atomic vectors.

But they have attributes and special methods that make them behave differently.

'squarebrackets' treats derived atomic classes as regular atomic vectors.

There are highly specialized packages to handle objects derived from atomic objects.

For example the 'forcats' package for handling factors, and the 'anytime' package to handle date-time objects.

### Not Supported S3 structures

Key-Values storage S3 structures, such as environments, are not supported by 'squarebrackets'.

---

aaa2\_squarebrackets\_coercion

*Auto-Coercion Rules*

---

## Description

This help page describes the auto-coercion rules of the supported classes, as they are handled by the 'squarebrackets' package.

## Coercion Rules for Immutable Classes

### Atomic

[coercion\\_through\\_copy](#): YES

Atomic objects are automatically coerced to fit the modified subset values, when modifying through copy.

For example, replacing one or multiple values in an integer vector (type `int`) with a decimal number (type `dbl`) will coerce the entire vector to type `dbl`.

### Derived From Atomic

[coercion\\_through\\_copy](#): depends

Factors, datetime, POSIXct and so on are derived from atomic vectors, but have attributes and special methods that make them behave differently.

Depending on their behaviour, they may or may not allow coercion.

Factors, for example, only accept values that are part of their levels, and thus do not support coercion on modification.

There are highly specialized packages to handle objects derived from atomic objects. For example the 'forcats' package for handling factors, and the 'anytime' package to handle ddate-time objects.

### List

[coercion\\_through\\_copy](#): depends

Lists themselves allow complete change of their elements, since lists are merely pointers. For example, the following code performs full coercion:

```
x <- list(factor(letters), factor(letters))
sb_mod(x, 1, rp = list(1))
```

However, a recursive subset of a list which itself is not a list, follows the coercion rules of whatever class the recursive subset is.

For example the following code:

```
x <- list(1:10, 1:10)
sb_rec(x, 1, rp = "a") # coerces to character
```

transforms recursive subsets according to the - in this case - atomic auto-coercion rules.

### Data.frames when replacing/transforming whole columns

[coercion\\_through\\_copy](#): YES

A data.frame is actually a list, where each column is itself a list. As such, replacing/transforming whole columns, so `row = NULL` and `filter = NULL`, allows completely changing the type of the column.

Note that coercion of columns needs arguments `row = NULL` and `filter = NULL` in the [sb\\_mod](#) and [sb\\_set](#) methods; no auto-coercion will take place when specifying something like `row = 1:nrow(x)` (see next section).

### Data.frames, when partially replacing/transforming columns

[coercion\\_through\\_copy](#): NO

If rows are specified in the [sb\\_mod](#) and [sb\\_set](#) methods, and thus not whole columns but parts of columns are replaced or transformed, no auto-coercion takes place.

I.e.: replacing/transforming a value in an integer (int) column to become 1.5, will not coerce the column to the decimal type (dbl); instead, the replacement value 1.5 is coerced to integer 1.

The `coe` argument in the [sb\\_mod](#) method allows the user to enforce coercion, even if subsets of columns are replaced/transformed instead of whole columns.

Specifically, the `coe` arguments allows the user to specify a coercive function to be applied on the entirety of every column specified in `col` or `vars`; columns outside this subset are not affected.

This coercion function is, of course, applied before replacement (`rp`) or transformation (`tf()`).

## Coercion Rules for Mutable Classes

### Coercion Semantics

The mutable classes support "copy-on-modify" semantics like the immutable classes, but - unlike the immutable classes - they also support "pass-by-reference" semantics.

The `sb_mod` method modify subsets of an object through a **(partial) copy**.

The `sb_set` method and `dt_setcoe` function modify subsets of an object **by reference**.

These 2 copy semantics - "pass by reference" or "modify copy" - have slightly different auto-coercion rules.

These are explained in this section.

### mutable\_atomic

`coercion_through_copy`: YES

`coercion_by_reference`: NO

Mutable atomic objects are automatically coerced to fit the modified subset values, when modifying through copy, just like regular atomic classes.

For example, replacing one or multiple values in an integer vector (type `int`) with a decimal number (type `dbl`) will coerce the entire vector to type `dbl`.

Replacing or transforming subsets of mutable atomic objects **by reference** does not support coercion. Thus, for example, the following code,

```
x <- 1:16
sb_set(x, i = 1:6, rp = 8.5)
x
```

gives `c(rep(8, 6) 7:16)` instead of `c(rep(8.5, 6), 7:16)`, because `x` is of type integer, so `rp` is interpreted as type integer also.

### data.table, when replacing/transforming whole columns

`coercion_through_copy`: YES

`coercion_by_reference`: YES

A `data.table` is actually a list made mutable, where each column is itself a list. As such, replacing/transforming whole columns, so `row = NULL` and `filter = NULL`, allows completely changing the type of the column.

Note that coercion of columns needs arguments `row = NULL` and `filter = NULL` in the `sb_mod` and `sb_set` methods; no auto-coercion will take place when specifying something like `row = 1:nrow(x)` (see next section).

### data.table, when partially replacing/transforming columns

`coercion_through_copy`: NO

`coercion_by_reference`: NO

If rows are specified in the `sb_mod` and `sb_set` methods, and thus not whole columns but parts of columns are replaced or transformed, no auto-coercion takes place.

I.e.: replacing/transforming a value in an integer (`int`) column to become 1.5, will not coerce the column to the decimal type (`dbl`); instead, the replacement value 1.5 is coerced to integer 1.

The `coe` argument in the `sb_mod` method allows the user to enforce coercion, even if subsets of columns are replaced/transformed instead of whole columns.

Specifically, the `coe` arguments allows the user to specify a coercive function to be applied on the entirety of every column specified in `col` or `vars`; columns outside this subset are not affected.

This coercion function is, of course, applied before replacement (rp) or transformation (tf()).

### Views of Lists

[coercion\\_by\\_reference](#): depends

Regular lists themselves are not treated as mutable objects by 'squarebrackets'.

However, lists are not actually really objects, merely a (potentially hierarchical) structure of pointers.

Thus, even if a list itself is not treated as mutable, subsets of a list which are themselves mutable classes, are mutable.

For example, if you have a list of data.table objects, the data.tables themselves are mutable.

Therefore, the following will work:

```
x <- list(
  a = data.table(cola = 1:10, colb = letters[1:10]),
  b = data.table(cola = 11:20, colb = letters[11:20])
)
mypointer <- x$a
sb_set(mypointer, col = "cola", tf = \(x)x^2)
```

Notice in the above code that mypointer is not a copy of x\$a, since they have the same address.

Thus changing mypointer also changes x\$a.

In other words: mypointer is what could be called a "view" of x\$a.

Notice also that sb\_set(x\$a, ...) will not work, since sb\_set() requires **actual variables**, similar to in-place functions in the style of `myfun()<-`.

The auto-coercion rules of Views of Lists, depends entirely on the object itself.

Thus if the View is a data.table, coercion rules of data.tables apply.

And if the View is a [mutable\\_atomic](#) matrix, coercion rules of [mutable\\_atomic](#) matrices apply, etc.

### Examples

```
# Coercion examples - mutable_atomic ====
```

```
x <- as.mutable_atomic(1:16)
sb_set(x, i = 1:6, rp = 8.5) # 8.5 coerced to 8, because `x` is of type `integer`
print(x)
```

```
#####
```

```
# Coercion examples - data.table - whole columns ====
```

```
# sb_mod():
obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
sb2_mod(
  obj, vars = is.numeric,
  tf = sqrt # SAFE: row=NULL & filter = NULL, so coercion performed
```

```

)

# sb_set():
sb2_set(
  obj, vars = is.numeric,
  tf = sqrt # SAFE: row=NULL & filter = NULL, so coercion performed
)
str(obj)

#####

# Coercion examples - data.table - partial columns ====

# sb_mod():
obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)

sb2_mod(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt
  # WARNING: sqrt() results in `dbl`, but columns are `int`, so decimals lost
)
sb2_mod(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  coe = as.double, tf = sqrt # SAFE: coercion performed
)

# sb_set():
obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
sb2_set(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt
  # WARNING: sqrt() results in `dbl`, but columns are `int`, so decimals lost
)
print(obj)

obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj)
dt_setcoe(obj, vars = is.numeric, v = as.numeric)
str(obj)
sb2_set(obj,
  filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # SAFE: coercion performed by dt_setcoe(); so no warnings
)
print(obj)

#####

```

```
# View of List ====

x <- list(
  a = data.table::data.table(cola = 1:10, colb = letters[1:10]),
  b = data.table::data.table(cola = 11:20, colb = letters[11:20])
)
print(x)
mypointer <- x$a
address(mypointer) == address(x$a) # they are the same
sb2_set(mypointer, col = "cola", tf = \ (x)x^2)
print(x) # notice x has been changed
```

---

aaa3\_squarebrackets\_indx\_args

*Index Arguments in the Generic Sub-setting Methods*


---

## Description

There are several types of arguments that can be used in the generic methods of 'squarebrackets' to specify the indices to perform operations on:

- `i`: to specify flat (i.e. dimensionless) indices.
- `row`, `col`: to specify rows and/or columns in tabular objects.
- `sub`, `dims`: to specify indices of arbitrary dimensions in arrays.
- `filter`, `vars`: to specify rows and/or columns specifically in data.frame-like objects.
- `margin`, `slice`: to specify indices of one particular dimension.

In this help page `x` refers to the object on which subset operations are performed.

## Fundamentals

Base 'R' supports indexing through logical, integer, and character vectors. 'squarebrackets' supports these also (albeit with some improvements), but also supports some additional methods of indexing.

### Whole numbers

Whole numbers are the most basic form on index selection.

All forms of indexing in 'squarebrackets' are internally translated to integer (or double if  $> (2^{31} - 1)$ ) indexing first, ensuring consistency.

Indexing through integer/numeric indices in 'squarebrackets' works the same as in base 'R', except that negative values are not allowed.

### Logical

Selecting indices with a logical vector in 'squarebrackets' works the same as in base 'R', except that recycling is not allowed.

Thus the logical vector must be of the correct length (i.e. `length(x)` or `dim(x)[L]`, depending on the situation).

### Characters

When selecting indices using a character vector, base 'R' only selects the first matches in the names. 'squarebrackets', however, selects ALL matches.

Character indices are internally translated to integer indices using [match\\_all](#).

### Imaginary Numbers

A [complex](#) vector `y` is structured as

$$y = a + b * i$$

where `Re(y)` returns `a`, and `Im(y)` returns `b`.

'squarebrackets' includes support for indexing through imaginary numbers (`Im(y)`) of [complex](#) vectors.

Indexing with imaginary numbers is a generalization of indexing with regular integers.

It works as follows:

Imaginary numbers that are positive integers, like `1:10 * 1i`, work the same as regular integers.

Imaginary numbers that are negative integers, like `1:10 * -1i`, index by counting backwards (i.e. from the end), where the integer indices are computed as `n + Im(y) + 1L`.

Here `n` is the maximum possible integer (i.e. `length(x)`, or `dim(x)[L]`, depending on the situation), and `Im(y)` is negative.

Note that **only** the Imaginary part of a complex vector is used (`Im(y)`); the Real part (`Re(y)`) is **ignored**.

See the results of the following code as an example:

```
x <- 1:30 # vector of 30 elements

sb_x(x, 1:10 * 1i) # extract first 10 elements
#> [1] 1 2 3 4 5 6 7 8 9 10

sb_x(x, 1:10 * -1i) # extract last 10 elements
#> [1] 30 29 28 27 26 25 24 23 22 21

sb_x(x, 10:1 * -1i) # last 10 elements, in tail()-like order
#> [1] 21 22 23 24 25 26 27 28 29 30
```

Thus complex vectors allow the user to choose between counting from the beginning, like regular integers, or counting from the end.

What follows are detailed descriptions of the common arguments in 'squarebrackets' used to select indices.

**Argument i**

class: atomic vector  
 class: derived atomic vector  
 class: recursive vector

Any of the following can be specified for argument i:

- NULL, corresponds to missing argument.
- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).
- a **strictly positive whole numbers** vector with indices.
- a **complex** vector, as explained at the start of this help page.
- a **logical vector**, of the same length as x, giving the indices to select for the operation.
- a **character** vector of index names.  
 If an object has multiple indices with the given name, ALL the corresponding indices will be selected for the operation.
- a **function** that takes as input x, and returns a logical vector, giving the element indices to select for the operation.  
 For atomic objects, i is interpreted as i(x).  
 For recursive objects, i is interpreted as lapply(x, i).

Using the i arguments corresponds to doing something like the following:

```
sb_x(x, i = i) # ==> x[i]
```

**Arguments row, col**

class: atomic matrix  
 class: recursive matrix  
 class: data.frame-like

Any of the following can be specified for the arguments row / col:

- NULL (default), corresponds to a missing argument.
- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).
- a **strictly positive whole numbers** vector with dimension indices to select for the operation.
- a **complex** vector, as explained at the start of this help page.
- a **logical** vector of the same length as the corresponding dimension size, giving the indices of this dimension to select for the operation.
- a **character** vector of index names.  
 If a dimension has multiple indices with the given name, ALL the corresponding indices will be selected for the operation.

NOTE: The arguments row and col will be ignored if i is specified.

Using the row, col arguments corresponds to doing something like the following:

```
sb_x(x, row = row, col = col) # ==> x[row, col, drop = FALSE]
```



**Argument Pair sub, dims**

class: atomic array

class: recursive array

The sub, dims argument pair is inspired by the `abind::asub` function from the 'abind' package (see reference below).

dims must be an integer vector of the same length as sub, giving the dimensions over which to select indices (i.e. dims specifies the "non-missing" index margins).

sub must be a list of subscripts, of the same length as dims. Each element of sub can be any of the following:

- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).
- a **strictly positive whole numbers** vector with dimension indices to select for the operation.
- a **complex** vector, as explained at the start of this help page.
- a **logical** vector of the same length as the corresponding dimension size, giving the indices of this dimension to select for the operation.
- a **character** vector of index names.

If a dimension has multiple indices with the given name, ALL the corresponding indices will be selected for the operation.

Note also the following:

- If dims is a single integer, one can specify sub as an atomic vector of any of the above specified types, instead of as a list of length 1.
- As stated, dims specifies which index margins are non-missing.  
If dims - and thus also sub - is of length 0, it is taken as "all index margins are missing".

To keep the syntax short, the user can use the `n` function instead of `list()` to specify sub.

Using the sub, dims arguments, corresponds to doing something like the following, here using an example of extracting subsets from a 4-dimensional array:

```
sb_x(x, n(1:10, 1:5), c(1, 3)) # ==> x[1:10, , 1:5, , drop = FALSE]
```

For a brief explanation of the relationship between flat indices (i), and dimensional subscripts (sub, dims), see the Details section in [sub2ind](#).

**Arguments filter, vars**

class: data.frame-like

filter must be a one-sided formula with a single logical expression using the column names of the data.frame, giving the condition which observation/row indices should be selected for the operation. For example, to perform an operation on the rows for which column height > 2 and for which column sex != "female", specify the following formula:

```
~ (height > 2) & (sex != "female")
```

If the formula is linked to an environment, any variables not found in the data set will be searched from the environment.

`vars` must be a function that returns a logical vector, giving the column indices to select for the operation.

For example, to select all numeric columns, specify `vars = is.numeric`.

### Argument Pair `margin`, `slice`

class: atomic array  
 class: recursive array  
 class: data.frame-like

Relevant only for the `idx` method.

The `margin` argument specifies the dimension on which argument `slice` is used.

I.e. when `margin = 1`, `slice` selects rows;

when `margin = 2`, `slice` selects columns;

etc.

The `slice` argument can be any of the following:

- a **strictly positive whole numbers** vector with dimension indices to select for the operation.
- a **complex** vector, as explained at the start of this help page.
- a **logical** vector of the same length as the corresponding dimension size, giving the dimension indices to select for the operation.
- a **character** vector of index names.  
 If a dimension has multiple indices with the given name, ALL the corresponding indices will be selected for the operation.

One could also give a vector of length 0 for `slice`;

Argument `slice` is only used in the `idx` method, and the result of `idx` are meant to be used inside the regular `[]` and `[<-]` operators.

Thus the result of a zero-length index specification depends on the rule-set of `[][.class(x)]` and `[<-][.class(x)]`.

### Argument `inv`

all classes

Relevant for the `sb_mod/sb2_mod`, `sb_set/sb2_set`, and `idx` methods.

By default, `inv = FALSE`, which translates the indices like normally.

When `inv = TRUE`, the inverse of the indices is taken.

Consider, for example, an atomic matrix `x`;

using `sb_mod(x, col = 1:2, tf = tf)` corresponds to something like the following:

```
x[, 1:2] <- tf(x[, 1:2])
x
```

and using `sb_mod(x, col = 1:2, inv = TRUE, tf = tf)` corresponds to something like the following:

```
x[, -1:-2] <- tf(x[, -1:-2])
x
```

#### NOTE

The order in which the user gives indices when `inv = TRUE` generally does not matter.

The order of the indices as they appear in the original object `x` is maintained, just like in base 'R'.

Therefore, when replacing multiple values where the order of the replacement matters, it is better to keep `inv = FALSE`, which is the default.

For replacement with a single value or with a transformation function, `inv = TRUE` can be used without considering the ordering.

#### All NULL indices

NULL in the indexing arguments corresponds to a missing argument.

Thus, for **both** `sb_x` and `sb_rm`, using NULL for all indexing arguments corresponds to something like the following:

```
x[]
```

Similarly, for `sb_mod` and `sb_set`, using NULL corresponds to something like the following:

```
x[] <- rp # for replacement
x[] <- tf(x) # for transformation
```

The above is true **even if** `inv = TRUE` and/or `red = TRUE`.

#### Out-of-Bounds Integers, Non-Existing Names/Levels, and NAs

- Integer indices that are out of bounds (including NaN and `NA_integer_`) always give an error.
- Specifying non-existing names/levels (including `NA_character_`) as indices is considered a form of zero-length indexing.
- Logical indices are translated internally to integers using `which`, and so NAs are ignored.

#### Disallowed Combinations of Index Arguments

One cannot specify `i` and the other indexing arguments simultaneously; it's either `i`, or the other arguments.

One cannot specify `row` and `filter` simultaneously; it's either one or the other.

One cannot specify `col` and `vars` simultaneously; it's either one or the other.

One cannot specify the sub, dims pair and slice, margin pair simultaneously; it's either one pair or the other pair.

In the above cases it holds that if one set is specified, the other is set is ignored.

## Drop

Sub-setting with the generic methods from the 'squarebrackets' R-package using dimensional arguments (row, col, lyr, sub, dims, filter, vars) always use drop = FALSE.

To drop potentially redundant (i.e. single level) dimensions, use the [drop](#) function, like so:

```
sb_x(x, row = row, col = col) |> drop() # ==> x[row, col, drop = TRUE]
```

## Regarding Performance

Integer indices and logical indices are the fastest.

Indexing through names or levels (i.e. character vectors) is the slowest.

Thus if performance is important, use integer or logical indices.

## References

Plate T, Heiberger R (2016). *abind: Combine Multidimensional Arrays*. R package version 1.4-5, <https://CRAN.R-project.org/package=abind>.

---

aaa4\_squarebrackets\_method\_dispatch

*Method Dispatch of 'squarebrackets'*

---

## Description

This help page gives some additional details regarding the S3 method dispatch used in 'squarebrackets'.

## Atomic vs Recursive

With the exception of the [idx](#) method, the main generic methods are available in 2 forms:

The Atomic form (sb\_), and the Recursive Form (sb2\_).

This because some S3 classes are available in both atomic and recursive forms.

For example, the [array](#) S3 class and the [matrix](#) S3 class (which inherits from the "array" S3 class) have both an atomic form, and a recursive form.

Atomic and recursive objects are quite different from each other in some ways:

- **homo- or heterogeneous:** an atomic object can only have values of one data type. recursive objects can hold values of any combination of data types.

- **copy semantics:** One can copy a subset of a recursive object without copying the rest of the object (thus saving memory when copying). For atomic objects, however, a copy operation copies the entire vector (ignoring attributes).
- **vectorization:** most vectorized operations generally work on atomic objects, whereas recursive objects often require loops or apply-like functions.
- **recursive subsets:** Recursive objects distinguish between "regular" subset operations (in base R using `[]`, `[]<-`), and recursive subset operations (in base R using `[[`, `[[<-`). For atomic objects, these 2 have no meaningful difference (safe for perhaps attribute handling).
- **views:** For recursive objects, one can create a subset [view](#) of a recursive subset. Recursive subset views do not exist for atomic objects.

Despite these differences, R'S S3 method dispatch system does not have a built-in method to have separate dispatches for recursive and atomic objects.

Hence, given all the above, the 'squarebrackets' package has separate methods for recursive and atomic objects.

## Manual Dispatch

The 'squarebrackets' package intentionally exports each function in its S3 method dispatch system. This is handy for programming purposes.

For example: atomic matrices and atomic arrays each have their own dispatch.

Thus, when looping through matrices and arrays to extract some elements, it may be easier to treat them all as arrays (remember that matrices inherit from arrays).

Thus one can use `sb_x.array()` to ensure the "array" method is used, instead of the "matrix" method.

Another advantage is that one can alias a specific dispatch of a method, if one so desires.

I.e.: `array2_x <- sb2_x.array`.

Under certain circumstances, this may help your code to be more clear.

## Ellipsis

Due to how the S3 method dispatch system works in 'R', all generic methods have the ellipsis argument (`...`).

For the user's safety, 'squarebrackets' does check that the user doesn't accidentally add arguments that make no sense for that method (like specifying the `inv` argument when calling `sb_x`).

## Description

This help page describes the main modification semantics available in 'squarebrackets'.

### Base R's default modification

For most average users, R's default copy-on-modify semantics are fine.

The benefits of the indexing arguments from 'squarebrackets' can be combined the [ $\leftarrow$ ] operator, through the [idx](#) method.

The result of the `idx()` method can be used inside the regular square-brackets operators.

For example like so:

```
x <- array(...)
my_indices <- idx(x, sub, dims)
x[my_indices] <- value

y <- data.frame(...)
rows <- idx(y, 1:10, 1, inv = TRUE)
cols <- idx(y, c("a", "b"), 2)
y[rows, cols] <- value
```

thus allowing the user to benefit from the convenient index translations from 'squarebrackets', whilst still using R's default copy-on-modification semantics (instead of the semantics provided by 'squarebrackets').

### Explicit Copy

'squarebrackets' provides the [sb\\_mod](#) method to modify through copy.

This method always copies the modification.

For recursive objects, [sb\\_mod](#) returns the original object, where only the modified subsets are copied, thus preventing unnecessary usage of memory.

### Pass-by-Reference

'squarebrackets' provides the [sb\\_set](#) method to modify by reference, meaning no copy is made at all.

Pass-by-Reference is fastest and the most memory efficient.

But it is also more involved than the other modification forms, and requires more thought.

See [squarebrackets\\_PassByReference](#) for more information.

**Arguments** `rp`, `tf`, `.lapply`

Using the `rp` argument in the modification methods, corresponds to something like the following:

```
x[...] <- rp
```

Using the `tf` argument (and `.lapply` argument, for recursive objects) in the modification methods, corresponds to something like the following:

```
x[...] <- tf(x[...]) # for atomic objects
x[...] <- .lapply(x[...], tf) # for recursive objects
```

where `tf` is a function that **returns** an object of appropriate type and size (so `tf` should not be a pass-by-reference function).

For recursive objects, `tf` is accompanied by the `.lapply` argument.

By default, `.lapply = lapply`.

The user may supply a custom `lapply()`-like function in this argument to use instead.

For example, to perform parallel transformation, the user may supply `future.apply::future_lapply`.

The supplied function must use the exact same argument convention as [lapply](#), otherwise errors or unexpected behaviour may occur.

**Recycling and Coercion**

Recycling is not allowed in the modification methods.

So, for example, `length(rp)` must be equal to the length of the selected subset, or equal to 1.

The user should also take into account the auto-coercion rules of the object's class.

See [squarebrackets\\_coercion](#) for details.

---

aaa6\_squarebrackets\_options  
*squarebrackets Options*

---

**Description**

This help page explains the various global options that can be set for the 'squarebrackets' package, and how it affects the functionality.

## Check Duplicates

argument: `chkdup`

option: `squarebrackets.chkdup`

The `sb_x` method is the only method where providing duplicate indices actually make sense.

For the other methods, it doesn't make sense.

Giving duplicate indices usually won't break anything; however, when replacing/transforming or removing subsets, it is almost certainly not the intention to provide duplicate indices.

Providing duplicate indices anyway might lead to unexpected results.

Therefore, for the methods where giving duplicate indices does not make sense, the `chkdup` argument is present.

This argument controls whether the method in question checks for duplicates (TRUE) or not (FALSE).

Setting `chkdup = TRUE` means the method in question will check for duplicate indices, and give an error when it finds them.

Setting `chkdup = FALSE` will disable these checks, which saves time and computation power, and is thus more efficient.

Since checking for duplicates can be expensive, it is set to FALSE by default.

The default can be changed in the `squarebrackets.chkdup` option.

## Mutable Atomic Messages

option: `squarebrackets.ma_messages`

The `[<- .mutable_atomic` method notifies the user of copy-on-modification.

Should the user find this annoying, the user can disable these messages by setting `squarebrackets.ma_messages` to FALSE.

---

aaa7\_squarebrackets\_PassByReference

*Regarding Modification By Reference*

---

## Description

This help page describes how modification using "pass-by-reference" semantics is handled by the 'squarebrackets' package.

This help page does not explain all the basics of pass-by-reference semantics, as this is treated as prior knowledge.

All functions/methods in the 'squarebrackets' package with the word "set" in the name use pass-by-reference semantics.

## Advantages and Disadvantages

The main advantage of pass-by-reference is that much less memory is required to modify objects, and modification is also generally faster.



But it does have several disadvantages.

First, the coercion rules are slightly different: see [squarebrackets\\_coercion](#).

Second, if 2 or more variables refer to exactly the same object, changing one variable also changes the other ones.

I.e. the following code,

```
x <- y <- mutable_atomic(1:16)
sb_set(x, i = 1:6, rp = 8)
```

modifies not just x, but also y.

This is true even if one of the variables is locked (see [bindingIsLocked](#)).

I.e. the following code,

```
x <- mutable_atomic(1:16)
y <- x
lockBinding("y", environment())
sb_set(x, i = 1:6, rp = 8)
```

modifies both x and y without error, even though y is a locked constant.

### Mutable vs Immutable Classes

With the exception of environments, most of base R's S3 classes are treated as immutable: Modifying an object in 'R' will make a copy of the object, something called 'copy-on-modify' semantics.

A prominent mutable S3 class is the `data.table` class, which is a mutable `data.frame` class, and supported by 'squarebrackets'.

Similarly, 'squarebrackets' adds a class for mutable atomic objects:

[mutable\\_atomic](#).

### Material vs Immaterial objects

Most objects in 'R' are material objects:

the values an object contains are actually stored in memory.

For example, given `x <- rnorm(1e6)`, x is a material object:

1 million values (decimal numbers, in this case) are actually stored in memory.

In contrast, [ActiveBindings](#) are immaterial:

They are objects that, when accessed, call a function to generate values on the fly, rather than actually storing values.

Since immaterial objects do not actually store the values in memory, the values obviously also cannot be changed in memory.

Therefore, Pass-by-Reference semantics **do not work** on immaterial objects.

## ALTREP

the `mutable_atomic` constructors (i.e. `mutable_atomic`, `as.mutable_atomic`, etc.) will automatically materialize ALTREP objects, to ensure consistent behaviour for 'pass-by-reference' semantics.

A `data.table` can have ALTREP columns.

A `data.tables` will coerce the column to a materialized column when it is modified, even by reference.

This works since a `data.table` is a recursive object.

## Mutability Rules With Respect To Recursive Objects

Lists are difficult objects in that they do not contain elements, they simply point to other objects, that one can access via a list.

When a recursive object is of a mutable class, all its subsets are treated as mutable, as long as they are part of the object.

On the other hand, When a recursive object is of an immutable class, than its recursive subsets retain their original mutability.

### Example 1: Mutable `data.tables`

A `data.table` is a mutable class.

So all columns of the `data.table` are treated as mutable;

There is no requirement to, for instance, first change all columns into the class of `mutable_atomic` to modify these columns by reference.

### Example 2: Immutable lists

A regular list is an immutable class.

So the list itself is immutable, but the recursive subsets of the list retain their mutability.

If you have a list of `data.table` objects, for example, the `data.tables` themselves remain mutable.

Therefore, the following pass-by-reference modification will work without issue:

```
x <- list(
  a = data.table(cola = 1:10, colb = letters[1:10]),
  b = data.table(cola = 11:20, colb = letters[11:20])
)
mypointer <- x$a
sb_set(mypointer, col = "cola", tf = \(x)x^2)
```

Notice in the above code that `mypointer` has the same address as `x$a`, and is therefore not a copy of `x$a`.

Thus changing `mypointer` also changes `x$a`.

In other words: `mypointer` is what could be called a "**View**" of `x$a`.

## Input Variable

Methods/functions that perform in-place modification by reference only works on objects that actually exist as an actual variable, similar to functions in the style of `some_function(x, ...) <-`

value.

Thus things like any of the following,

```
sb_set(1:10, ...), sb2_set(x$a, ...), or sb_set(base::letters),
```

will not work.

## Lock Binding

Mutable classes are, as the name suggests, meant to be mutable.

Locking the binding of a mutable object is **mostly** fruitless (but not completely; see the [current-Bindings](#) function).

To prevent modification of an object's binding, 2 things must be true:

- the object must be an immutable class.
- the binding must be **locked** (see [lockBinding](#)).

Some packages that provide pass-by-reference semantics tend to ignore the lock of an object's binding.

Use the 'squarebrackets' methods and (of course) core/base 'R' methods, in case the user fears the binding locks will not be respected.

## Protection

Due to the properties described above in this help page, something like the following will not work:

```
# letters = base::letters
sb_set(letters, i = 1, rp = "XXX")
```

The above won't work because:

1. addresses in `baseenv()` are protected;
2. immutable objects are disallowed (you'll have to create a mutable object, which will create a copy of the original, thus keeping the original object safe from modification by reference);
3. locked bindings are disallowed.

Despite the checks made by this package, the user should never actively try to modify a **locked** or **protected** object by reference, as that would defeat the purpose of locking an object.

## Examples

```
# the following code demonstrates how locked bindings,
# such as `base::letters`,
# are being safe-guarded
```

```

x <- list(a = base::letters)
mypointer <- x$a # view of a list
address(mypointer) == address(base::letters) # TRUE: point to the same memory
bindingIsLocked("letters", baseenv()) # base::letters is locked ...
bindingIsLocked("mypointer", environment()) # ... but this pointer is not!

if(requireNamespace("tinytest")) {
  tinytest::expect_error(
    sb_set(mypointer, i = 1, rp = "XXX") # this still gives an error though ...
  )
}

is.mutable_atomic(mypointer) # ... because it's not of class `mutable_atomic`

x <- list(
  a = as.mutable_atomic(base::letters) # `as.mutable_atomic()` makes a copy
)
mypointer <- x$a # view of a list
address(mypointer) == address(base::letters) # FALSE: it's a copy
sb_set(
  mypointer, i = 1, rp = "XXX" # modifies x, does NOT modify `base::letters`
)
print(x) # x is modified
base::letters # but this still the same

```

---

aaa8\_squarebrackets\_inconveniences

*Examples Where the Square Bracket Operators Are Less Convenient*


---

## Description

This help page shows some examples where the square bracket operators ( `[`, `[<-`) are less than optimally convenient, and how the methods provided by 'squarebrackets' can be helpful in those cases.

## Arrays

In order to perform subset operations on some array `x` with the square brackets operator (`[`, `[<-`), one needs to know how many dimensions it has. I.e. if `x` has 3 dimensions, one would use:

```
x[i, j, k, drop = FALSE]
```

```
x[i, j, k] <- value
```

But how would one use the `[` and `[<-` operators, when number of dimensions of `x` is not known a-priori?

It's not impossible, but still rather convoluted.

The methods provided by 'squarebrackets' do not use position-based arguments, and as such work on any arbitrary dimensions without requiring prior knowledge; see [squarebrackets\\_indx\\_args](#) for details.

When extracting/removing dimensional sub-set from an array, i.e. `x[indx1, indx2]`, `dimnames(x)` will be preserved (within the range of the subset of course), but `names(x)` will be dropped completely.

The methods provided by 'squarebrackets' do not completely remove `names(x)` when extracting/removing subsets.

After all: why bother giving arrays flat names if they'll be stripped anyway?

### Rule-sets for data.frame-like Objects

The [data.frame](#), [tibble](#), [data.table](#), and [tidytable](#) classes all inherit from class "data.frame".

Yet they use different rules regarding the usage of the square bracket operators.

Constantly switching between these rules is annoying, and makes one's code inconsistent.

The methods provided by 'squarebrackets' use the same sub-setting rules for all data.frame inherited classes, thus solving this issue.

The 'squarebrackets' package attempts to keep the data.frame methods as class agnostic as possible, through the class agnostic functionality of the 'collapse' and 'data.table' R-packages.

This attempt to keep data.frame-like classes consistent does, admittedly, result in some oddities in how data.frames are treated by 'squarebrackets', compared to how other classes are treated by 'squarebrackets':

- Whole-columns will be auto-coerced when replaced/transformed by [sb\\_mod](#), but partial columns will not be auto-coerced by default.
- The [sb\\_x](#) and [sb\\_rm](#) methods always automatically conserve all attributes (though names and dimensions are adjusted accordingly, of course); the attributes are not stripped, unlike the other classes.
- Giving a data.frame-like object with non-unique column names to the `sb_`-methods returns an error; duplicating columns with [sb\\_x](#) will automatically adjust the column names to make them unique.

### Long Vectors

Performing sub-set operations on a long vector `x` using `[`, like any other object, requires an indexing vector.

The indexing vector may need to be of type double (since long vectors can be longer than  $2^{31} - 1$ ), and the indexing vector may need to be very large itself also.

This can be quite inefficient, as one may need up to twice the memory of the object itself.

'squarebrackets' provides the [slice\\_](#) methods, which can perform sub-set operations on large atomic vectors, **without** the need of any indexing vector at all.

Note that dimensional objects, such as arrays and data.frame-like objects, are in less dire need of a `slice_` method due to dimensional indexing:

For example, a 1500 by 1500 by 1500 array is already a long vector ( $1500^3 > (2^{31} - 1)$ ), yet one does not need indexing vectors longer than 1500 elements or of type double.

### Annoying Sub-setting By Names

When selecting names for sub-setting, only the first occurrences of the names are selected for the sub-set;

and when un-selecting/removing names for sub-setting, the syntax is very different from selecting names.

The methods provided by 'squarebrackets' uses the same syntax for both selecting and removing sub-sets.

Moreover, selecting/removing sub-sets by names always selects/removes all sub-sets with the given names, not just the first match.

### Modification Semantics

'R' adheres to copy-on-modify semantics when replacing values using `[<-`.

But sometimes one would like explicit control when to create a copy, and when to modify using pass-by-reference semantics.

The 'squarebrackets' package provides the `sb_mod` method to return a copy of an object with modified subsets, and the `sb_set` method to modify using pass-by-reference semantics.

The `idx` method can be used in combination with R's own `[<-` operator for R's default copy-on-modify semantics.

### Regarding Other Packages

There are some packages that solve some of these issues.

But using different packages for solving different issues for the same common theme (in this case: solving some inconveniences in the square bracket operators) leads to inconsistent code.

I have not found an R-package that provides a holistic approach to providing alternative methods to the square brackets operators.

Thus, this 'R' package was born.

## Description

The `bind_` and `bind2_` implementations provide dimensional binding functionalities.

`bind_` is for atomic objects, and `bind2_` for recursive objects.

When possible, the `bind_`/`bind2_` functions return [mutable classes](#).

The following implementations are available:

- `bind_mat()` binds dimensionless atomic vectors and atomic matrices row- or column-wise.  
Returns a [mutable\\_atomic](#) matrix.
- `bind2_mat()` binds dimensionless recursive vectors and recursive matrices row- or column-wise.  
Returns a recursive matrix (immutable).
- `bind_array()` binds atomic arrays and matrices.  
Returns a [mutable\\_atomic](#) array.
- `bind2_array()` binds recursive arrays and matrices.  
Returns a recursive array (immutable).
- `bind2_dt()` binds `data.tables` and other `data.frame`-like objects.  
Returns a `data.table`.  
Faster than `do.call(cbind, ...)` or `do.call(rbind, ...)` for regular `data.frame` objects.

Note that the naming convention of the binding implementations here is "`bind_`"/"`bind2_`" followed by the **resulting class** (abbreviated).

I.e. `bind_mat` **returns** a matrix, but can bind both matrices and vectors.

And `bind_array` **returns** an array, but can bind both arrays and matrices.

And `bind2_dt` **returns** a `data.table`, but can bind not only `data.tables`, but also most other `data.frame`-like objects.

## Usage

```
bind_mat(arg.list, along, deparse.level = 1)
```

```
bind2_mat(arg.list, along, deparse.level = 1)
```

```
bind_array(
  arg.list,
  along,
  name_along = TRUE,
  comnames_from = 1L,
  name_flat = FALSE
)
```

```
bind2_array(
  arg.list,
  along,
  name_along = TRUE,
  comnames_from = 1L,
```

```

    name_flat = FALSE
  )

  bind2_dt(arg.list, along)

```

## Arguments

- |                            |  |
|----------------------------|--|
| <code>arg.list</code>      | a list of only the appropriate objects.<br>Do not mix recursive and atomic objects in the same list, as that may result in unexpected results.   |
| <code>along</code>         | a single integer, indicating the dimension along which to bind the dimensions.<br>I.e. use <code>along = 1</code> for row-binding, <code>along = 2</code> for column-binding, etc.<br>For arrays, additional flexibility is available: <ul style="list-style-type: none"> <li>• Specifying <code>along = 0</code> will bind the arrays on a new dimension before the first, making <code>along</code> the new first dimension.</li> <li>• Specifying <code>along = n+1</code>, with <code>n</code> being the last available dimension, will create an additional dimension (<code>n+1</code>) and bind the arrays along that new dimension.</li> </ul> |
| <code>deparse.level</code> | see <a href="#">cbind</a> and <a href="#">rbind</a> .  |
| <code>name_along</code>    | Boolean, for <code>bind_array()</code> and <code>bind2_array()</code> .<br>Indicates if dimension <code>along</code> should be named.  |
| <code>comnames_from</code> | integer scalar or <code>NULL</code> , for <code>bind_array()</code> and <code>bind2_array()</code> .<br>Indicates which object in <code>arg.list</code> should be used for naming the shared dimension.<br>If <code>NULL</code> , no communal names will be given.<br>For example:<br>When binding columns of atomic matrices, <code>comnames_from = 1</code> results in <code>bind_array()</code> using <code>rownames(arg.list[[1]])</code> for the row names of the output.   |
| <code>name_flat</code>     | Boolean, for <code>bind_array()</code> and <code>bind2_array()</code> .<br>Indicates if flat indices should be named.<br>Note that setting this to <code>TRUE</code> will reduce performance considerably.<br><a href="#">for performance: set to FALSE</a>  |

## Details

`bind_array()` and `bind2_array()` are modified versions of the fantastic `abind::abind` function by Tony Plare and Richard Heiberger (see reference below).  
`bind_array()` has slightly better performance than `abind::abind`, and has more streamlined naming options.  
`bind2_array()` also has the streamlined naming options, and additionally differs from `abind::abind` in that it can handle recursive arrays properly (the original `abind::abind` function would unlist everything to atomic arrays).

`bind_mat()` and `bind2_mat()` are modified versions of [rbind/cbind](#).  
 The primary difference is that `bind_mat()/bind2_mat()` give an error when fractional recycling is attempted (like binding `1:3` with `1:10`).



**Value**

The new object.

**References**

Plate T, Heiberger R (2016). *abind: Combine Multidimensional Arrays*. R package version 1.4-5, <https://CRAN.R-project.org/package=abind>.

**Examples**

```
# atomic arrays ====
x <- matrix(1:12,3,4)
dimnames(x) <- n(letters[1:3], LETTERS[1:4])
names(x) <- month.abb
print(x)
y <- x+100
arg.list <- list(x = x, y = y)
bind_array(arg.list, along=0, name_flat = TRUE) # binds on new dimension before first
bind_array(arg.list, along=1, name_flat = TRUE) # binds on first dimension
bind_array(arg.list, along=2, name_flat = TRUE)
bind_array(arg.list, along=3, name_flat = TRUE) # bind on new dimension after last

#####

# recursiv arrays ====
x <- matrix(as.list(1:12),3,4)
dimnames(x) <- n(letters[1:3], LETTERS[1:4])
names(x) <- month.abb
print(x)
y <- lapply(x, \(x) + 100)
dim(y) <- dim(x)
arg.list <- list(x = x, y=y)
bind2_array(arg.list, along=0, name_flat = TRUE) # binds on new dimension before first
bind2_array(arg.list, along=1, name_flat = TRUE) # binds on first dimension
bind2_array(arg.list, along=2, name_flat = TRUE)
bind2_array(arg.list, along=3, name_flat = TRUE) # bind on new dimension after last
```

---

ci\_flat

---

*Construct Indices*


---

**Description**

These functions construct flat or dimensional indices.

- `ci_flat()` constructs an integer vector flat indices.
- `ci_margin()` constructs an integer vector of indices for one particular dimension margin.
- `ci_sub()` constructs a list of integer subscripts.

- `ci_df()` is the same as `ci_margin()`, except it is specifically designed for `data.frame`-like objects.  
It is a separate function, because things like `dimnames(x)[1]` and `rownames(x)` do not always return the same output for certain `data.frame`-like objects.

### Usage

```
ci_flat(  
  x,  
  i,  
  inv = FALSE,  
  chkdup = FALSE,  
  uniquely_named = FALSE,  
  .abortcall = sys.call()  
)  
  
ci_margin(  
  x,  
  slice,  
  margin,  
  inv = FALSE,  
  chkdup = FALSE,  
  uniquely_named = FALSE,  
  .abortcall = sys.call()  
)  
  
ci_sub(  
  x,  
  sub,  
  dims,  
  inv = FALSE,  
  chkdup = FALSE,  
  uniquely_named = FALSE,  
  .abortcall = sys.call()  
)  
  
ci_df(  
  x,  
  slice,  
  margin,  
  inv = FALSE,  
  chkdup = FALSE,  
  uniquely_named = FALSE,  
  .abortcall = sys.call()  
)
```

### Arguments

`x` the object for which the indices are meant.  
`i, slice, margin, sub, dims, inv`  
See [squarebrackets\\_idx\\_args](#).

chkdup	see <a href="#">squarebrackets_options</a> . for performance: set to FALSE
uniquely_named	Boolean, indicating if the user knows a-priori that the relevant names of x are unique. If set to TRUE, speed may increase. But specifying TRUE when the relevant names are not unique will result in incorrect output.
.abortcall	environment where the error message is passed to.

### Value

An integer vector of casted indices.

### Examples

```
x <- matrix(1:25, 5, 5)
colnames(x) <- c("a", "a", "b", "c", "d")
print(x)

bool <- sample(c(TRUE, FALSE), 5, TRUE)
int <- 1:4
chr <- c("a", "a")
cplx <- 1:4 * -1i
tci_bool(bool, nrow(x))
tci_int(int, ncol(x), inv = TRUE)
tci_chr(chr, colnames(x))
tci_cplx(cplx, nrow(x))

ci_flat(x, 1:10 * -1i)
ci_margin(x, 1:4, 2)
ci_sub(x, n(1:5 * -1i, 1:4), 1:2)
```

---

class\_mutable\_atomic    *Mutable Atomic Classes*

---

### Description

The mutable\_atomic class is a mutable version of atomic classes.

It works exactly the same in all aspects as regular atomic classes, with only one real difference: The 'squarebrackets' methods and functions that perform modification by reference (basically all methods and functions with "set" in the name) accept mutable\_atomic, but do not accept regular atomic.

See [squarebrackets\\_PassByReference](#) for details.

Like data.table, [ $\leftarrow$ ] performs R's default copy-on-modification semantics.  
For modification by reference, use [sb\\_set](#).

Exposed functions (beside the S3 methods):

- mutable\_atomic(): create a mutable\_atomic object from given data.

- `couldb.mutable_atomic()`: checks if an object could become `mutable_atomic`.  
An objects can become `mutable_atomic` if it is one of the following types:  
[logical](#), [integer](#), [double](#), [character](#), [complex](#), [raw](#).  
`bit64::integer64` type is also supported, since it is internally defined as [double](#).
- `materialize_atomic()`: takes an immaterial ALTREP atomic object, and returns a materialized `mutable_atomic` object.
- `typecast.mutable_atomic()` type-casts and possibly reshapes a (mutable) atomic object, and returns a `mutable_atomic` object.  
Does not preserve dimension names if dimensions are changed.

## Usage

```
mutable_atomic(data, names = NULL, dim = NULL, dimnames = NULL)

as.mutable_atomic(x, ...)

is.mutable_atomic(x)

couldb.mutable_atomic(x)

typecast.mutable_atomic(x, type = typeof(x), dims = dim(x))

materialize_atomic(x)

## S3 method for class 'mutable_atomic'
c(..., use.names = TRUE)

## S3 method for class 'mutable_atomic'
x[...]
```

```
## S3 replacement method for class 'mutable_atomic'
x[...] <- value

## S3 method for class 'mutable_atomic'
format(x, ...)

## S3 method for class 'mutable_atomic'
print(x, ...)
```

## Arguments

<code>data</code>	atomic vector giving data to fill the <code>mutable_atomic</code> object.
<code>names, dim, dimnames</code>	see <a href="#">setNames</a> and <a href="#">array</a> .
<code>x</code>	an atomic object.
<code>...</code>	method dependent arguments.
<code>type</code>	a string giving the type; see <a href="#">typeof</a> .
<code>dims</code>	integer vector, giving the new dimensions.

use.names      Boolean, indicating if [names](#) should be preserved.  
 value          see [Extract](#).

### Value

For `mutable_atomic()`, `as.mutable_atomic()`, `materialize_atomic()`, `typecast.mutable_atomic()`:  
 Returns a `mutable_atomic` object.

For `is.mutable_atomic()`:  
 Returns TRUE if the object is `mutable_atomic`, and returns FALSE otherwise.

For `couldb.mutable_atomic()`:  
 Returns TRUE if the object is one of the following types:  
[logical](#), [integer](#), [double](#), [character](#), [complex](#), [raw](#).  
[bit64::integer64](#) type is also supported, since it is internally defined as [double](#).  
 Returns FALSE otherwise.

### Warning

Always use the exported functions given by 'squarebrackets' to create a `mutable_atomic` object, as they make necessary checks.  
 Circumventing these checks may break things!

### Examples

```
x <- mutable_atomic(
  1:20, dim = c(5, 4), dimnames = list(letters[1:5], letters[1:4])
)
x
typecast.mutable_atomic(x, "character")

x <- matrix(1:10, ncol = 2)
x <- as.mutable_atomic(x)
is.mutable_atomic(x)
print(x)
x[, 1]
x[] <- as.double(x)
print(x)
is.mutable_atomic(x)
```

### Description

`cp_seq()` returns a list of parameters to construct a sequence based on the margins of an object.  
 It is internally used by the [idx\\_r](#) function and [slice](#) method.

## Usage

```
cp_seq(x, m = 0L, from = NULL, to = NULL, by = 1L)
```

## Arguments

x	the object for which to compute margin-based sequence parameters.
m	integer or complex, giving the margin(s). For non-dimensional objects or for flat indices, specify <code>m = 0L</code> .
from	integer or complex, of the same length as <code>m</code> or of length 1, specifying the from point.
to	integer or complex, of the same length as <code>m</code> or of length 1, specifying the <b>maximally allowed</b> end value.
by	integer, of the same length as <code>m</code> or of length 1, specifying the step size.

## Value

A list of the following elements:

`$start`:

The actual starting point of the sequence.

This is simply `from` translated to regular numeric.

`$end`:

The **actual** ending point of the sequence.

This is **not** the same as `to`, not even whe translated to regular numeric.

For example, the following code:

```
seq(from = 1L, to = 10L, by = 2L)
#> [1] 1 3 5 7 9
```

specifies `to = 10L`.

But the sequence doesn't actually end at 10; it ends at 9.

Therefore, `cp_seq(x, m, 1, 10, 2)` will return `end = 9`, not `end = 10`.

This allows the user to easily predict where an sequence given in [idx\\_r/slice](#) will actually end.

`$by`:

This will give `by`, but with it's sign adjusted, if needed.

`$length.out`:

The actual vector lengths of the sequences would be, given the translated parameters.

## Arguments Details

### Multiple dimensions at once

The `cp_seq` function can construct the sequence parameters needed for multiple dimensions at once, by specifying a vector for `m`.

The lengths of the other arguments are then recycled if needed.

**Using only by**

If from, to are not specified, using by will construct the following sequence:

If by is positive, `seq.int(1L, n, by)`.

If by is negative, `seq.int(n, 1L, by)`.

Where n is the maximum index (i.e. `length(x)` or `dim(x)[m]`, depending on the situation).

**Using from, to, by**

If from, to, by are all specified, by is stored as `abs(by)`, and the sign of by is automatically adjusted to ensure a sensible sequence is created.

So, for example, to construct the parameters to get `n:1`, one can simply call `cp_seq(x, m, by = -1L)`.

**Examples**

```
x <- data.frame(
  a = 1:10, b = letters[1:10], c = factor(letters[1:10]), d = -1:-10
)
print(x)
ind1 <- idx_r(x, 1, 2, 2* -1i) # rows 2:(nrow(x)-1)
sb2_x(x, ind1) # extract the row range

x <- array(1:125, c(5,5,5))
dims <- 1:3
sub <- idx_r(x, dims, 2, 2* -1i) # 2:(n-1) for every dimension
sb_x(x, sub, dims) # same as x[ 2:4, 2:4, 2:4, drop = FALSE]

x <- letters
x[idx_r(x, 0, 2, 2* -1i)]
```

---

currentBindings

*List or Lock All Currently Existing Bindings Pointing To Same Address*


---

**Description**

`currentBindings(x, action = "list")`

lists all **currently existing** objects sharing the same **address** as x, in a given environment.

`currentBindings(x, action = "checklock")`

searches all **currently existing** objects sharing the same **address** as x, in a given environment, and reports which of these are locked and which are not locked.

`currentBindings(x, action = "lockbindings")`

searches all **currently existing** objects sharing the same **address** as x, in a given environment, and locks them using [lockBinding](#).

See also [squarebrackets\\_PassByReference](#) for information regarding the relation between locked bindings and pass-by-reference modifications.

## Usage

```
currentBindings(x, action = "list", env = NULL)
```

## Arguments

x	the existing variable whose address to use when searching for bindings.
action	a single string, giving the action to perform. Must be one of the following: <ul style="list-style-type: none"> <li>• "list" (default).</li> <li>• "checklock".</li> <li>• "lockbindings".</li> </ul>
env	the environment where to look for objects. If NULL (default), the caller environment is used.

## Details

The [lockBinding](#) function locks a binding of an object, preventing modification. 'R' also uses locked bindings to prevent modification of objects from package namespaces. The pass-by-reference semantics of 'squarebrackets' in principle respect this, and disallows modification of objects by reference.

However, [lockBinding](#) does not lock the address/pointer of an object, only one particular binding of an object.

This problematic; consider the following example:

```
x <- mutable_atomic(1:16)
y <- x
lockBinding("y", environment())
sb_set(x, i = 1:6, rp = 8)
```

In the above code, x and y share the same address, thus pointing to the same memory, yet only y is actually locked.

Since x is not locked, modifying x is allowed.

But since `sb_set()/sb2_set()` performs modification by reference, y will still be modified, despite being locked.

The `currentBindings()` function allows to user to: find all **currently existing** bindings in the **caller environment** sharing the same address as x, and locking all these bindings.



**Value**

For `currentBindings(x, action = "list")`:  
Returns a character vector.

For `currentBindings(x, action = "checklock")`:  
Returns a named logical vector.  
The names give the names of the bindings,  
and each associated value indicates whether the binding is locked (TRUE) or not locked (FALSE).

For `currentBindings(x, action = "lockbindings")`:  
Returns VOID. It just locks the currently existing bindings.  
To unlock the bindings, remove the objects (see [rm](#)).

**Warning**

The `currentBindings()` function only locks **currently existing** bindings in the **specified environment**;  
bindings that are created **after** calling `currentBindings()` will not automatically be locked.  
Thus, every time the user creates a new binding of the same object, and the user wishes it to be locked, `currentBindings()` must be called again.

**Examples**

```
x <- as.mutable_atomic(1:10)
y <- x
lockBinding("y", environment())
currentBindings(x)
currentBindings(x, "checklock") # only y is locked

# since only y is locked, we can still modify y through x by reference:
sb_set(x, i = 1, rp = -1)
print(y) # modified!
rm(list= c("y")) # clean up

# one can fix this by locking ALL bindings:
y <- x
currentBindings(x, "lockbindings") # lock all
currentBindings(x, "checklock") # all bindings are locked, including y
# the 'squarebrackets' package respects the lock of a binding,
# provided all bindings of an address are locked;
# so this will give an error, as it should:

if(requireNamespace("tinytest")) {
  tinytest::expect_error(
    sb_set(x, i = 1, rp = -1),
    pattern = "object is locked"
  )
}
```

```
# creating a new variable will NOT automatically be locked:
z <- y # new variable; will not be locked!
currentBindings(x, "checklock") # z is not locked
currentBindings(x, "lockbindings") # we must re-run this
currentBindings(x, "checklock") # now z is also locked

if(requireNamespace("tinytest")) {
  tinytest::expect_error( # now z is also protected
    sb_set(z, i = 1, rp = -1),
    pattern = "object is locked"
  )
}

rm(list= c("x", "y", "z")) # clean up
```

dt

*Functional Forms of data.table Operations***Description**

Functional forms of special data.table operations.

These functions do not use Non-Standard Evaluation.

These functions also benefit from the security measures that 'squarebrackets' implements for the [pass-by-reference semantics](#).

- `dt_aggregate()` aggregates a data.table or tidytable, and returns the aggregated copy.
- `dt_setcof()` coercively transforms columns of a data.table or tidytable using [pass-by-reference semantics](#).
- `dt_setrm()` removes columns of a data.table or tidytable using [pass-by-reference semantics](#).
- `dt_setadd(x, new)` adds the columns from data.table/tidytable new to data.table/tidytable x, thereby modifying x using [pass-by-reference semantics](#).
- `dt_setreorder()` reorders the rows and/or variables of a data . table using [pass-by-reference semantics](#).

**Usage**

```
dt_aggregate(x, SDcols = NULL, f, by, order_by = FALSE)
```

```
dt_setcof(
  x,
  col = NULL,
  vars = NULL,
  v,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
```

```

)

dt_setrm(
  x,
  col = NULL,
  vars = NULL,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

dt_setadd(x, new)

dt_setreorder(x, roworder = NULL, varorder = NULL)

```

### Arguments

<code>x</code>	a <code>data.table</code> or <code>tidytable</code> .
<code>SDcols</code>	atomic vector, giving the columns to which the aggregation function <code>f()</code> is to be applied on.
<code>f</code>	the aggregation function
<code>by</code>	atomic vector, giving the grouping columns.
<code>order_by</code>	Boolean, indicating if the aggregated result should be ordered by the columns specified in <code>by</code> .
<code>col, vars</code>	see <a href="#">squarebrackets_indx_args</a> . Duplicates are not allowed.
<code>v</code>	the coercive transformation function
<code>chkdup</code>	see <a href="#">squarebrackets_options</a> . for performance: set to <code>FALSE</code>
<code>new</code>	a <code>data.frame</code> -like object. It must have column names that do not already exist in <code>x</code> .
<code>roworder</code>	a integer vector of the same length as <code>nrow(x)</code> , giving the order in which the rows are to be re-order. Internally, this numeric vector will be turned into an order using <a href="#">order</a> , thus ensuring it is a strict permutation of <code>1:nrow(x)</code> .
<code>varorder</code>	integer or character vector of the same length as <code>ncol(x)</code> , giving the new column order. See <code>data.table::setcolororder</code> .

### Details

`dt_setreorder(x, roworder = roworder)` internally creates a new column to reorder the `data.table` by, and then removes the new column.  
The column name is randomized, and extra care is given to ensure it does not overwrite any existing columns.

### Value

For `dt_aggregate()`:  
The aggregated `data.table` object.

For the rest of the functions:

Returns: VOID. These functions modify the object by reference.

Do not use assignments like `x <- dt_setcoe(x, ...)`.

Since these functions return void, you'll just get NULL.

## Examples

```
# dt_aggregate on sf-data.table ====
```

```
if(requireNamespace("sf")) {
  x <- sf::st_read(system.file("shape/nc.shp", package = "sf"))
  x <- data.table::as.data.table(x)

  x$region <- ifelse(x$CNTY_ID <= 2000, 'high', 'low')
  d.aggr <- dt_aggregate(
    x, SDcols = "geometry", f= sf::st_union, by = "region"
  )

  head(d.aggr)
}
```

```
#####
```

```
# dt_setcoe ====
```

```
obj <- data.table::data.table(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
sb2_set(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # WARNING: sqrt() results in `dbl`, but columns are `int`, so decimals lost
)
str(obj)
obj <- data.table::data.table(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
dt_setcoe(obj, vars = is.numeric, v = as.numeric) # integers are now numeric
str(obj)
sb2_set(obj,
  filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # SAFE: coercion performed; so no warnings
)
str(obj)
```

```
#####
```

```
# dt_setrm ====
```

```
obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj)
```

```

dt_setrm(obj, col = 1)
str(obj)

obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
str(obj)
dt_setrm(obj, vars = is.numeric)
str(obj)

#####

# dt_setadd ====

obj <- data.table::data.table(
  a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10])
)
new <- data.table::data.table(
  e = sample(c(TRUE, FALSE), 10, TRUE),
  f = sample(c(TRUE, FALSE), 10, TRUE)
)
dt_setadd(obj, new)
print(obj)

#####

# dt_setreorder====

n <- 1e4
obj <- data.table::data.table(
  a = 1L:n, b = n:1L, c = as.double(1:n), d = as.double(n:1)
)
dt_setreorder(obj, roworder = n:1)
head(obj)
dt_setreorder(obj, varorder = ncol(obj):1)
head(obj)

```

idx

*Convert/Translate Indices (for Copy-On-Modify Substitution)***Description**

The `idx()` method converts indices.

The type of output depends on the type of input index arguments given:

- `idx(x, i = i, ...)` converts linear indices to a strictly positive integer vector of linear indices.
- `idx(x, sub = sub, dims = dims, ...)` converts dimensional indices to a strictly positive integer vector of linear indices.

- `idx(x, slice = slice, margin = margin, ...)` converts indices of one dimension to a strictly positive integer vector of indices for that specific dimension.

Vectors (both atomic and recursive) only have index argument `i`.

Data.frame-like objects only have the `slice`, `margin` index argument pair.

Arrays (both atomic and recursive) have the `sub`, `dims` index argument pair, as well as the arguments `i` and `slice`, `margin`.

The result of the `idx()` method can be used inside the regular square-brackets operators.

For example like so:

```
x <- array(...)
my_indices <- idx(x, sub, dims)
x[my_indices] <- value

y <- data.frame(...)
rows <- idx(y, 1:10, 1, inv = TRUE)
cols <- idx(y, c("a", "b"), 2)
y[rows, cols] <- value
```

thus allowing the user to benefit from the convenient index translations from 'squarebrackets', whilst still using R's default copy-on-modification semantics (instead of the semantics provided by 'squarebrackets').

## Usage

```
idx(x, ...)
```

## Default S3 method:

```
idx(x, i, inv = FALSE, ..., chkdup = getOption("squarebrackets.chkdup", FALSE))
```

## S3 method for class 'array'

```
idx(
  x,
  sub = NULL,
  dims = NULL,
  slice = NULL,
  margin = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)
```

## S3 method for class 'data.frame'

```
idx(
  x,
  slice,
  margin,
  inv = FALSE,
```

```

    ...,
    chkdup = getOption("squarebrackets.chkdup", FALSE)
)

```

### Arguments

**x** vector, matrix, array, or data.frame; both atomic and recursive objects are supported.

**...** see [squarebrackets\\_method\\_dispatch](#).

**i, sub, dims, margin, slice, inv** See [squarebrackets\\_idx\\_args](#). Duplicates are not allowed.

**chkdup** see [squarebrackets\\_options](#).  
for performance: set to FALSE

### Value

For `idx(x, i = i, ...)` and `idx(x, sub = sub, dims = dims, ...)`:  
A strictly positive integer vector of flat indices.

For `idx(x, margin = margin, slice = slice, ...)`:  
A strictly positive integer vector of indices for the dimension specified in margin.

### Examples

```

# atomic ====

x <- 1:10
x[idx(x, \ (x)x>5)] <- -5
print(x)

x <- array(1:27, dim = c(3,3,3))
x[idx(x, n(1:2, 1:2), c(1,3))] <- -10
print(x)

#####

# recursive ====

x <- as.list(1:10)
x[idx(x, \ (x)x>5)] <- -5
print(x)

x <- array(as.list(1:27), dim = c(3,3,3))
x[idx(x, n(1:2, 1:2), c(1,3))] <- -10
print(x)

x <- data.frame(
  a = sample(c(TRUE, FALSE, NA), 10, TRUE),

```

```

b = 1:10,
c = rnorm(10),
d = letters[1:10],
e = factor(letters[11:20])
)
rows <- idx(x, 1:5, 1, inv = TRUE)
cols <- idx(x, c("b", "a"), 2)
x[rows, cols] <- NA
print(x)

```

idx\_by

*Compute Grouped Indices***Description**

Given:

- a sub-set function `f`;
- an object `x` with its margin `m`;
- and a grouping factor `grp`;

the `idx_by()` function takes indices **per group** `grp`.

The result of `idx_by()` can be supplied to the indexing arguments (see [squarebrackets\\_idx\\_args](#)) to perform **grouped** subset operations.

**Usage**

```
idx_by(x, m, f, grp, parallel = FALSE, mc.cores = 1L)
```

**Arguments**

- |                                 |   |
|---------------------------------|---|
| <code>x</code>                  | the object from which to compute the indices.   |
| <code>m</code>                  | a single non-negative integer giving the margin for which to compute indices.<br>For flat indices or for non-dimensional objects, use <code>m = 0L</code> .   |
| <code>f</code>                  | a subset function to be applied per group on indices.<br>If <code>m == 0L</code> , indices is here defined as <code>setNames(1:length(x), names(x))</code> .<br>If <code>m &gt; 0L</code> , indices is here defined as <code>setNames(1:dim(x)[m], dimnames(x)[[m]])</code> .<br>The function must produce a character or integer vector as output.<br>For example, to subset the last element per group, specify:<br><code>f = last</code> |
| <code>grp</code>                | a factor giving the groups.   |
| <code>parallel, mc.cores</code> | see <a href="#">BY</a> .  |

**Value**

A vector of indices.



## Examples

```
# vectors ====
(a <- 1:20)
(grp <- factor(rep(letters[1:5], each = 4)))

# get the last element of `a` for each group in `grp`:
i <- idx_by(a, 0L, last, grp)
sb_x(cbind(a, grp), row = i)

# data.frame ====
x <- data.frame(
  a = sample(1:20),
  b = letters[1:20],
  group = factor(rep(letters[1:5], each = 4))
)
print(x)
# get the first row for each group in data.frame `x`:
row <- idx_by(x, 1, first, x$group)
sb2_x(x, row)
# get the first row for each group for which a > 10:
x2 <- sb2_x(x, filter = ~ a > 10)
row <- na.omit(idx_by(x2, 1, first, x2$group))
sb2_x(x2, row)
```

idx\_ord\_v

*Compute Ordered Indices*

## Description

Computes ordered indices. Similar to [order](#), except the user must supply a vector, a list of equal-length vectors, a data.frame or a matrix (row-wise and column-wise are both supported), as the input.

For a vector `x`,  
`idx_ord_v(x)` is equivalent to  
[order\(x\)](#).

For a data.frame or a list of equal-length vectors `x`, with `p` columns/elements,  
`idx_ord_df(x)` is equivalent to  
`order(x[[1]], ..., x[[p]])`.

For a matrix (or array) `x` with `p` rows,  
`idx_ord_m(x, margin = 1)` is equivalent to  
`order(x[1, ], ..., x[p, ], ...)`.

For a matrix (or array) `x` with `p` columns,  
`idx_ord_m(x, margin = 2)` is equivalent to  
`order(x[, 1], ..., x[, p], ...)`.

Note that these are merely convenience functions, and that these are actually slightly slower than [order](#) (except for `idx_ord_v()`), due to the additional functionality.

### Usage

```
idx_ord_v(
  x,
  na.last = TRUE,
  decr = FALSE,
  method = c("auto", "shell", "radix")
)

idx_ord_m(
  x,
  margin,
  na.last = TRUE,
  decr = FALSE,
  method = c("auto", "shell", "radix")
)

idx_ord_df(
  x,
  na.last = TRUE,
  decr = FALSE,
  method = c("auto", "shell", "radix")
)
```

### Arguments

<code>x</code>	a vector, data.frame, or array
<code>na.last, method</code>	see <a href="#">order</a> and <a href="#">sort</a> .
<code>decr</code>	see argument decreasing in <a href="#">order</a>
<code>margin</code>	the margin over which to cut the matrix/array into vectors. I.e. <code>margin = 1L</code> will cut <code>x</code> into individual rows, and apply the <a href="#">order</a> on those rows. And <code>margin = 2L</code> will cut <code>x</code> into columns, etc.

### Value

See [order](#).

### Examples

```
x <- sample(1:10)
order(x)
idx_ord_v(x)
idx_ord_m(rbind(x, x), 1)
idx_ord_m(cbind(x, x), 2)
idx_ord_df(data.frame(x, x))
```

---

idx_r	<i>Compute Integer Index Range</i>
-------	------------------------------------

---

**Description**

idx\_r() computes integer index range(s).

**Usage**

```
idx_r(x, m = 0L, from = NULL, to = NULL, by = 1L)
```

**Arguments**

x                      the object for which to compute subset indices.  
 m, from, to, by      see [cp\\_seq](#).

**Value**

If length(m) == 1L: a vector of numeric indices.

If length(m) > 1L: a list of the same length as m, containing numeric vectors of indices.

**Examples**

```
x <- data.frame(
  a = 1:10, b = letters[1:10], c = factor(letters[1:10]), d = -1:-10
)
print(x)
ind1 <- idx_r(x, 1, 2, 2* -1i) # rows 2:(nrow(x)-1)
sb2_x(x, ind1) # extract the row range

x <- array(1:125, c(5,5,5))
dims <- 1:3
sub <- idx_r(x, dims, 2, 2* -1i) # 2:(n-1) for every dimension
sb_x(x, sub, dims) # same as x[ 2:4, 2:4, 2:4, drop = FALSE]

x <- letters
x[idx_r(x, 0, 2, 2* -1i)]
```

---

indx_x	<i>Exported Utilities</i>
--------	---------------------------

---

**Description**

Exported utilities.  
Usually the user won't need these functions.

**Usage**

```
indx_x(i, x, xnames, xsize)

indx_rm(i, x, xnames, xsize)
```

**Arguments**

- i See [squarebrackets\\_indx\\_args](#).
- x a vector, vector-like object, factor, data.frame, data.frame-like object, or a list.
- xnames names or dimension names
- xsize length or dimension size

**Value**

The subsetted object.

**Examples**

```
x <- 1:10
names(x) <- letters[1:10]
indx_x(1:5, x, names(x), length(x))
indx_rm(1:5, x, names(x), length(x))
```

---

lst	<i>Unnest Tree-like List to Recursive 2d Array or Flattened Recursive Vector</i>
-----	--

---

**Description**

[[, [[<-, [sb2\\_rec](#), and [sb2\\_recin](#), can performing recursive subset operation on a nested list. Such recursive subset operations only operate on a single element. Performing recursive subset operations on multiple elements is not vectorized, and requires a (potentially slow) loop.

The `lst_untree()` function takes a nested tree-like list, and turns it into a 2d recursive array (i.e. a list-matrix), allowing vectorized subset operations to be performed on the list.

`lst_untree()` can also simply flatten the list, making it a non-nested list.  
See the Examples section to understand how the list will be arranged and named.

The `lst_nlists()` counts the total number of recursive list-elements inside a list.

## Usage

```
lst_nlists(x)
```

```
lst_untree(x, margin, use.names = FALSE)
```

## Arguments

<code>x</code>	a tree-like nested list.
<code>margin</code>	a single integer, indicating how the result should be arranged: <ul style="list-style-type: none"> <li>• <code>margin = 0</code> produces a simple flattened recursive vector (i.e. list) without dimensions.</li> <li>• <code>margin = 1</code> produces a 2D recursive array (i.e. a matrix of lists), with <code>length(x)</code> rows and <code>n</code> columns, where <code>n = sapply(x, lst_nlists)  &gt; max()</code>. Empty elements will be filled with <code>list(NULL)</code>.</li> <li>• <code>margin = 2</code> produces a 2D recursive array (i.e. a matrix of lists), with <code>length(x)</code> columns and <code>n</code> rows, where <code>n = sapply(x, lst_nlists)  &gt; max()</code>. Empty elements will be filled with <code>list(NULL)</code>.</li> </ul>
<code>use.names</code>	Boolean, indicating if the elements returned from <code>lst_untree()</code> should be named. Names of nested elements, such as <code>x[[c("A", "B", "C")]]</code> , will become "A.B.C", as that is the behaviour of the <code>rapply</code> function (which <code>lst_untree()</code> calls internally). It is therefore advised not to use dots (".") in your list names, and use under-scores ("_") instead, before calling <code>lst_untree()</code> . See the <code>rrapply::rrapply</code> function for renaming (and other forms of transforming) recursive subsets of lists.

## Value

For `lst_untree()`:

A non-nested (dimensional) list.

Note that if `margin = 1` or `margin = 2`, `lst_untree()` returns a recursive matrix (i.e. a recursive array with 2 dimensions), **not** a data.frame.

(One advantage of a recursive matrix over a data.frame, is that a recursive matrix can have separate column names and regular names, whereas the names of a data.frame are necessarily equal to the column names).

For `lst_nlists()`:

A single integer, giving the total number of recursive list-elements in the given list.

## Examples

```
# show-casing how the list-elements are arranged and named ====

x <- list(
  A = list(
    A = list(A = "AAA", B = "AAB"),
    A = list(A = "AA2A", B = "AA2B"),
    B = list(A = "ABA", B = "ABB"),
    C = letters
  ),
  Y = list(
    Z = list(Z = "YZZ", Y = "YZY"),
    Y = list(Z = "YYZ", Y = "YYY"),
    X = "YX"
  )
)

# un-tree column-wise:
sapply(x, lst_nlists) |> max() # number of rows `y` will have
y <- lst_untree(x, margin = 2, use.names = TRUE)
dim(y)
print(y)
y[["Y.Z.Y"]] # you can still use names for selecting/replacing
sb2_x(y, 1:3, 1:2) # vectorized selection of multiple recursive elements

# un-tree row-wise:
sapply(x, lst_nlists) |> max() # number of columns `y` will have
y <- lst_untree(x, margin = 1, use.names = TRUE)
dim(y)
print(y)
y[["Y.Z.Y"]] # you can still use names for selecting/replacing
sb2_x(y, 1:2, 1:3) # vectorized selection of multiple recursive elements

# simple flattened list:
y <- lst_untree(x, margin = 0, use.names = TRUE)
print(y)
y[["Y.Z.Y"]]
x[[c("Y", "Z", "Y")]] # equivalent in the original list

#####

# showcasing that only list-elements are recursively flattened ====
# i.e. atomic vectors in recursive subsets remain atomic

x <- lapply(1:10, \(x)list(sample(letters), sample(1:10)))

sapply(x, lst_nlists) |> max()
y <- lst_untree(x, margin = 1)
dim(y)
print(y)

lst_untree(x, margin = 1)
```

```
#####

# showcasing vectorized sub-setting ====
x <- lapply(1:10, \(x) list(
  list(sample(letters[1:10]), sample(LETTERS[1:10])),
  list(sample(month.abb), sample(month.name)),
  list(sample(1:10), rnorm(10))
))
y <- lst_untree(x, 1)

# getting the first recursive elements in the second level/depth in base R:
for(i in seq_along(x)) {
  x[[c(i, c(1,1))]]
}

# the same, but vectorized using the untree'd list:
y[seq_len(nrow(y)), 1]
```

---

match\_all

---

*Match All, Order-Sensitive and Duplicates-Sensitive*


---

## Description

Find all indices of vector haystack that are equal to vector needles, taking into account the order of both vectors, and their duplicate values.

It is essentially a much more efficient version of:

```
lapply(needles, \(i) which(haystack == i))
```

Like `lapply(needles, \(i) which(haystack == i))`, NAs are ignored.

Core of the code is based on a suggestion by Sebastian Kranz (author of the 'collapse' package).

## Usage

```
match_all(needles, haystack, unlist = TRUE)
```

## Arguments

needles, haystack

vectors

unlist

Boolean, indicating if the result should be a single integer vector (TRUE, default), or a list (length = length(needles)) of integer vectors (FALSE).

**Value**

An integer vector, or list of integer vector.

If a list, each element of the list corresponds to each value of needles.

When needles and/or haystack is/are empty or fully NA, `match_all()` returns an empty integer vector (if `unlist = TRUE`), or an empty list (if `unlist = FALSE`).

**Examples**

```
n <- 200
haystack <- sample(letters, n, TRUE)
needles <- sample(letters, n/2, TRUE)
indices1 <- match_all(needles, haystack)
head(indices1)
```

---

ma_setv	<i>Find and Replace Present Values in mutable_atomic Objects By Reference</i>
---------	---

---

**Description**

The `ma_setv(x, v, rp)` function performs the equivalent of  
`x[which(x == v)] <- rp`  
but using [pass-by-reference semantics](#).

This is faster than using `sb_set(x, i = which(x == v), rp = rp)`.

Inspired by `collapse::setv`, but written in 'C++' through 'Rcpp', with additional safety checks.

**Usage**

```
ma_setv(x, v, rp, invert = FALSE, NA.safety = TRUE)
```

**Arguments**

<code>x</code>	a <a href="#">mutable_atomic variable</a> .
<code>v</code>	non-missing (so no NA or NaN) atomic scalar to find.
<code>rp</code>	atomic scalar giving the replacement value.
<code>invert</code>	Boolean. If FALSE (default), the equivalent of <code>x[which(x == v)] &lt;- rp</code> is performed; If TRUE, the equivalent of <code>x[which(x != v)] &lt;- rp</code> is performed instead.
<code>NA.safety</code>	Boolean. just like in <a href="#">which</a> , NA and NaN results in <code>x==v</code> should be ignored, thus <code>NA.safety</code> is TRUE by default. However, if it is known that <code>x</code> contains no NAs or NaNs, setting <code>NA.safety</code> to FALSE will increase performance a bit.



NOTE: Setting `NA.safety = FALSE` when `x` does contain NAs or NaNs, may result in unexpected behaviour.

for performance: [set to FALSE](#)

## Value

Returns: VOID. This function modifies the object by reference.

Do not use assignment like `x <- ma_setv(x, ...)`.

Since this function returns void, you'll just get NULL.

## Examples

```
x <- mutable_atomic(c(1:20, NA, NaN))
print(x)
ma_setv(x, 2, 100)
print(x)
```

---

n	<i>Nest</i>
---	-------------

---

## Description

The `c()` function concatenates vectors or lists into a vector (if possible) or else a list.

In analogy to that function, the `n()` function **ne**sts objects into a list (not into an atomic vector, as atomic vectors cannot be nested).

It is a short-hand version of the [list](#) function.

This is handy because lists are often needed in 'squarebrackets', especially for arrays.

## Usage

```
n()
```

## Value

The list.

## Examples

```
obj <- array(1:64, c(4,4,3))
print(obj)
sb_x(obj, n(1:3, 1:2), c(1,3))
# above is equivalent to obj[1:3, , 1:2, drop = FALSE]
```

---

ndims	<i>Get Number of Dimensions</i>
-------	---------------------------------

---

**Description**

ndims(x) is short-hand for length(dim(x)).

**Usage**

```
ndims(x)
```

**Arguments**

x                      the object to get the number of dimensions from.

**Value**

An integer, giving the number of dimensions x has.  
For vectors, gives 0L.

**Examples**

```
x <- 1:10
ndims(x)
obj <- array(1:64, c(4,4,3))
print(obj)
ndims(obj)
```

---

sb2_rec	<i>Access, Replace, Transform, Remove, or Extend Recursive Subsets</i>
---------	--

---

**Description**

The sb2\_rec() and sb2\_recin() methods are essentially convenient wrappers around [] and []<-, respectively.

sb2\_rec() will access recursive subsets of lists.

sb2\_recin() can do the following things:

- replace or transform recursive subsets of a list, using R's default Copy-On-Modify semantics, by specifying the rp or tf argument, respectively.
- remove a recursive subset of a list, using R's default Copy-On-Modify semantics, by specifying argument rp = NULL.

- extending a list with additional recursive elements, using R's default Copy-On-Modify semantics.  
This is done by specifying an out-of-bounds index in argument `rec`, and entering the new values in argument `rp`.  
Note that adding surface level elements of a dimensional list will remove the dimension attributes of that list.

## Usage

```
sb2_rec(x, rec)
```

```
sb2_recin(x, rec, rp, tf)
```

## Arguments

- |                  |  |
|------------------|--|
| <code>x</code>   | a list, or list-like object.   |
| <code>rec</code> | <p>a strictly positive integer vector or character vector, of length <code>p</code>, such that <code>x[[rec]]</code> is equivalent to <code>x[[ rec[1] ]]</code>...<code>[[ rec[p] ]]</code>, providing all but the final indexing results in a list.</p> <p>When on a certain subset level of a nested list, multiple subsets with the same name exist, only the first one will be selected when performing recursive indexing by name, due to the recursive nature of this type of sub-setting.</p>  |
| <code>rp</code>  | <p>optional, and allows for multiple functionalities:</p> <ul style="list-style-type: none"> <li>• In the simplest case, performs <code>x[[rec]] &lt;- rp</code>, using R's default semantics. Since this is a replacement of a recursive subset, <code>rp</code> does not necessarily have to be a list itself; <code>rp</code> can be any type of object.</li> <li>• When specifying <code>rp = NULL</code>, will <b>remove</b> (recursive) subset <code>x[[rec]]</code>. To specify actual <code>NULL</code> instead of removing a subset, use <code>list(NULL)</code>.</li> <li>• When <code>rec</code> is an integer, and specifies an out-of-bounds subset, <code>sb2_recin()</code> will add value <code>rp</code> to the list.<br/>Any empty positions in between will be filled with <code>NA</code>.</li> <li>• When <code>rec</code> is character, and specifies a non-existing name, <code>sb2_recin()</code> will add value <code>rp</code> to the list as a new element at the end.</li> </ul> |
| <code>tf</code>  | <p>an optional function. If specified, performs <code>x[[rec]] &lt;- tf(x[[rec]])</code>, using R's default Copy-On-Modify semantics.</p> <p>Does not support extending a list like argument <code>rp</code>.</p>  |

## Details

Since recursive objects are pointers to objects, extending a list or removing an element of a list does not copy the entire list, in contrast to atomic vectors.

## Value

For `sb2_rec()`:  
Returns the recursive subset.

For `sb2_recin(..., rp = rp)`:

Returns VOID, but replaces, adds, or removes the specified recursive subset, using R's default Copy-On-Modify semantics.

For `sb2_recin(..., tf = tf)`:

Returns VOID, but transforms the specified recursive subset, using R's default Copy-On-Modify semantics.

## Examples

```
lst <- list(
  A = list(
    A = list(A = "AAA", B = "AAB"),
    A = list(A = "AA2A", B = "AA2B"),
    B = list(A = "ABA", B = "ABB")
  ),
  B = list(
    A = list(A = "BAA", B = "BAB"),
    B = list(A = "BBA", B = "BBB")
  )
)

#####

# access recursive subsets ====

sb2_rec(lst, c(1,2,2)) # this gives "AA2B"
sb2_rec(lst, c("A", "B", "B")) # this gives "ABB"
sb2_rec(lst, c(2,2,1)) # this gives "BBA"
sb2_rec(lst, c("B", "B", "A")) # this gives "BBA"

#####

# replace recursive subset with R's default in-place semantics ====

# replace "AAB" using R's default in-place semantics:
sb2_recin(
  lst, c("A", "A", "B"),
  rp = "THIS IS REPLACED WITH IN-PLACE SEMANTICS"
)
print(lst)

#####

# replace shallow subsets with R's default in-place semantics ====

for(i in c("A", "B")) sb2_recin(lst, i, rp = "AND THEN THERE WERE NONE")

print(lst)
```

```
#####

# Modify View of List By Reference ====

x <- list(
  a = data.table::data.table(cola = 1:10, colb = letters[1:10]),
  b = data.table::data.table(cola = 11:20, colb = letters[11:20])
)
print(x)
mypointer <- sb2_rec(x, "a")
address(mypointer) == address(x$a) # they are the same
sb2_set(mypointer, col = "cola", tf = \"(x)x^2)
print(x) # notice x has been changed
```

---

sb\_mod

---

*Method to Return a Copy of an Object With Modified Subsets*


---

## Description

This is an S3 Method to return a copy of an object with modified subsets.

Use `sb_mod(x, ...)` if `x` is an atomic object; this returns a full copy.

Use `sb2_mod(x, ...)` if `x` is a recursive object (i.e. list or data.frame-like); this returns a partial copy.

For modifying subsets using R's default copy-on-modification semantics, see [idx](#).

## Usage

```
sb_mod(x, ...)

## Default S3 method:
sb_mod(
  x,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'matrix'
sb_mod(
  x,
  row = NULL,
  col = NULL,
  i = NULL,
```

```

    inv = FALSE,
    ...,
    rp,
    tf,
    chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'array'
sb_mod(
  x,
  sub = NULL,
  dims = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

sb2_mod(x, ...)

## Default S3 method:
sb2_mod(
  x,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE),
  .lapply = lapply
)

## S3 method for class 'matrix'
sb2_mod(
  x,
  row = NULL,
  col = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE),
  .lapply = lapply
)

## S3 method for class 'array'
sb2_mod(
  x,
  sub = NULL,

```

```

    dims = NULL,
    i = NULL,
    inv = FALSE,
    ...,
    rp,
    tf,
    chkdup = getOption("squarebrackets.chkdup", FALSE),
    .lapply = lapply
)

## S3 method for class 'data.frame'
sb2_mod(
  x,
  row = NULL,
  col = NULL,
  filter = NULL,
  vars = NULL,
  inv = FALSE,
  coe = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE),
  .lapply = lapply
)

```

## Arguments

x	see <a href="#">squarebrackets_supported_structures</a> .
...	see <a href="#">squarebrackets_method_dispatch</a> .
i, row, col, sub, dims, filter, vars, inv	See <a href="#">squarebrackets_indx_args</a> . An empty index selection returns the original object unchanged.
rp, tf, .lapply	see <a href="#">squarebrackets_modify</a> .
chkdup	see <a href="#">squarebrackets_options</a> . <a href="#">for performance: set to FALSE</a>
coe	Either FALSE (default), TRUE, or a function. The argument coe is ignored if both the row and filter arguments are set to NULL. See Details section for more info. <a href="#">for performance: set to FALSE</a>

## Details

### Transform or Replace

Specifying argument tf will transform the subset.

Specifying rp will replace the subset.

One cannot specify both tf and rp. It's either one set or the other.

**Argument** `coe`

For data.frame-like objects, `sb_mod()` can only auto-coerce whole columns, not subsets of columns. So it does not automatically coerce column types when `row` or `filter` is also specified.

The `coe` arguments provides 2 ways to circumvent this:

1. The user can supply a coercion function to argument `coe`.  
The function is applied on the entirety of every column specified in `col` or `vars`; columns outside this subset are not affected.  
This coercion function is, of course, applied before replacement (`rp`) or transformation (`tf()`).
2. The user can set `coe = TRUE`.  
In this case, the whole columns specified in `col` or `vars` are extracted and copied to a list. Subsets of each list element, corresponding to the selected rows, are modified with `rp` or `tf()`, using R's regular auto-coercion rules.  
The modified list is then returned to the data.frame-like object, replacing the original columns.

Note that coercion required additional memory.

The larger the data.frame-like object, the larger the memory.

The default, `coe = FALSE`, uses the least amount of memory.

**Value**

A copy of the object with replaced/transformed values.

**Examples**

```
# atomic objects ====

obj <- matrix(1:16, ncol = 4)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
rp <- -1:-9
sb_mod(obj, 1:3, 1:3, rp = rp)
# above is equivalent to obj[1:3, 1:3] <- -1:-9; obj
sb_mod(obj, i = \(\x)x<=5, rp = -1:-5)
# above is equivalent to obj[obj <= 5] <- -1:-5; obj
sb_mod(obj, col = "a", rp = -1:-8)
# above is equivalent to obj[, which(colnames(obj) %in% "a")] <- -1:-8; obj
sb_mod(obj, 1:3, 1:3, tf = \(\x) -x)
# above is equivalent to obj[1:3, 1:3] <- (-1 * obj[1:3, 1:3]); obj
sb_mod(obj, i = \(\x)x<=5, tf = \(\x) -x)
# above is equivalent to obj[obj <= 5] <- (-1 * obj[obj <= 5]); obj

obj <- matrix(1:16, ncol = 4)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb_mod(obj, 1:3, 1:3, tf = \(\x) -x)
# above is equivalent to obj[1:3, 1:3] <- -1 * obj[1:3, 1:3]
sb_mod(obj, i = \(\x)x<=5, tf = \(\x) -x)
# above is equivalent to obj[obj <= 5] <- -1:-5; obj
sb_mod(obj, col = "a", tf = \(\x) -x)
# above is equivalent to obj[, which(colnames(obj) %in% "a")] <- -1:-8; obj
```



```

obj <- array(1:64, c(4,4,3))
print(obj)
sb_mod(obj, list(1:3, 1:2), c(1,3), rp = -1:-24)
# above is equivalent to obj[1:3, , 1:2] <- -1:-24
sb_mod(obj, i = \(\x)x<=5, rp = -1:-5)
# above is equivalent to obj[obj <= 5] <- -1:-5

#####

# lists ====

obj <- list(a = 1:10, b = letters[1:11], c = 11:20)
print(obj)
sb2_mod(obj, "a", rp = list(1L))
# above is equivalent to obj[["a"]] <- 1L; obj
sb2_mod(obj, is.numeric, rp = list(-1:-10, -11:-20))
# above is equivalent to obj[which(sapply(obj, is.numeric))] <- list(-1:-10, -11:-20); obj

#####

# dimensional lists ====
obj <- rbind(
  lapply(1:4, \(\x)sample(c(TRUE, FALSE, NA))),
  lapply(1:4, \(\x)sample(1:10)),
  lapply(1:4, \(\x)rnorm(10)),
  lapply(1:4, \(\x)sample(letters))
)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb2_mod(obj, 1:3, 1:3, rp = n(-1))
# above is equivalent to obj[1:3, 1:3] <- list(-1)
sb2_mod(obj, i = is.numeric, rp = n(-1))
# above is equivalent to obj[sapply(obj, is.numeric)] <- list(-1)
sb2_mod(obj, col = c("a"), rp = n(-1))
# above is equivalent to
# obj[, lapply(c("a", "a"), \(\i) which(colnames(obj) == i)) |> unlist()] <- list(-1)

obj <- array(as.list(1:64), c(4,4,3))
print(obj)
sb2_mod(obj, list(1:3, 1:2), c(1,3), rp = as.list(-1:-24))
# above is equivalent to obj[1:3, , 1:2] <- as.list(-1:-24)
sb2_mod(obj, i = \(\x)x<=5, rp = as.list(-1:-5))
# above is equivalent to obj[sapply(obj, \(\x) x <= 5)] <- as.list(-1:-5)

#####

# data.frame-like objects - whole columns ====

obj <- data.frame(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
sb2_mod(
  obj, vars = is.numeric,
  tf = sqrt # SAFE: row=NULL & filter = NULL, so coercion performed

```

```

)

#####

# data.frame-like objects - partial columns ====

obj <- data.frame(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)

sb2_mod(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # WARNING: sqrt() results in `dbl`, but columns are `int`, so decimals lost
)
sb2_mod(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  coe = as.double, tf = sqrt # SAFE: coercion performed
)
sb2_mod(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  coe = TRUE, tf = sqrt # SAFE: coercion performed
)

```

---

sb\_rm

---

*Method to Un-Select/Remove Subsets of an Object*


---

## Description

This is an S3 Method to un-select/remove subsets from an object.

Use `sb_rm(x, ...)` if `x` is an atomic object.

Use `sb2_rm(x, ...)` if `x` is a recursive object (i.e. list or data.frame-like).

## Usage

```

sb_rm(x, ...)

## Default S3 method:
sb_rm(x, i = NULL, ..., chkdup = getOption("squarebrackets.chkdup", FALSE))

## S3 method for class 'matrix'
sb_rm(
  x,
  row = NULL,
  col = NULL,
  i = NULL,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

```

```

## S3 method for class 'array'
sb_rm(
  x,
  sub = NULL,
  dims = NULL,
  i = NULL,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

sb2_rm(x, ...)

## Default S3 method:
sb2_rm(
  x,
  i = NULL,
  red = FALSE,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'matrix'
sb2_rm(
  x,
  row = NULL,
  col = NULL,
  i = NULL,
  red = FALSE,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'array'
sb2_rm(
  x,
  sub = NULL,
  dims = NULL,
  i = NULL,
  red = FALSE,
  ...,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'data.frame'
sb2_rm(
  x,
  row = NULL,
  col = NULL,
  filter = NULL,
  vars = NULL,
  ...,

```

```
    chkdup = getOption("squarebrackets.chkdup", FALSE)
  )
```

## Arguments

x	see <a href="#">squarebrackets_supported_structures</a> .
...	see <a href="#">squarebrackets_method_dispatch</a> .
i, row, col, sub, dims, filter, vars	See <a href="#">squarebrackets_indx_args</a> . An empty index selection results in nothing being removed, and the entire object is returned.
chkdup	see <a href="#">squarebrackets_options</a> . for performance: set to FALSE
red	Boolean, for list only. If red = TRUE, selecting a single element with non-empty arguments will give the simplified result, like using <code>[[ ]]</code> . If red = FALSE, a list is always returned regardless of the number of elements.

## Value

A copy of the sub-setted object.

## Examples

```
# atomic objects ====

obj <- matrix(1:16, ncol = 4)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb_rm(obj, 1:3, 1:3)
# above is equivalent to  obj[-1:-3, -1:-3, drop = FALSE]
sb_rm(obj, i = \"(x)>5\")
# above is equivalent to  obj[!obj > 5]
sb_rm(obj, col = "a")
# above is equivalent to  obj[, which(!colnames(obj) %in% "a")]

obj <- array(1:64, c(4,4,3))
print(obj)
sb_rm(obj, n(1, c(1, 3)), c(1, 3))
# above is equivalent to obj[-1, , c(-1, -3), drop = FALSE]
sb_rm(obj, i = \"(x)>5\")
# above is equivalent to obj[!obj > 5]

#####

# lists ====

obj <- list(a = 1:10, b = letters[1:11], c = 11:20)
print(obj)
```

```

sb2_rm(obj, "a")
# above is equivalent to obj[which(!names(obj) %in% "a")]
sb2_rm(obj, 1) # obj[-1]
sb2_rm(obj, 1:2)
# above is equivalent to obj[seq_len(length(obj))[-1:-2]]
sb2_rm(obj, is.numeric, red = TRUE)
# above is equivalent to obj[!sapply(obj, is.numeric)] IF this returns a single element
obj <- list(a = 1:10, b = letters[1:11], c = letters)
sb2_rm(obj, is.numeric)
# above is equivalent to obj[!sapply(obj, is.numeric)] # this time singular brackets?
# for recursive indexing, see sb2_rec()

#####

# dimensional lists ====

obj <- rbind(
  lapply(1:4, \x)sample(c(TRUE, FALSE, NA))),
  lapply(1:4, \x)sample(1:10)),
  lapply(1:4, \x)rnorm(10)),
  lapply(1:4, \x)sample(letters))
)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb2_rm(obj, 1:3, 1:3)
# above is equivalent to obj[1:3, 1:3, drop = FALSE]
sb2_rm(obj, i = is.numeric)
# above is equivalent to obj[sapply(obj, is.numeric)]
sb2_rm(obj, col = c("a", "a"))
# above is equivalent to obj[, lapply(c("a", "a"), \i) which(colnames(obj) == i)) |> unlist()]

obj <- array(as.list(1:64), c(4,4,3))
print(obj)
sb2_rm(obj, n(1, c(1, 3)), c(1, 3))
# above is equivalent to obj[-1, , c(-1, -3), drop = FALSE]
sb2_rm(obj, i = \x)x>5)
# above is equivalent to obj[!sapply(obj, \x) x > 5)]

#####

# data.frame-like objects ====

obj <- data.frame(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
print(obj)
sb2_rm(obj, 1:3, 1:3)
# above is equivalent to obj[-1:-3, -1:-3, drop = FALSE]
sb2_rm(obj, filter = ~ (a > 5) & (c < 19), vars = is.numeric)

```

---

sb\_set

---

*Method to Modify Subsets of a Mutable Object By Reference*


---

## Description

This is an S3 Method to replace or transform a subset of a [supported mutable object](#) using [pass-by-reference semantics](#)

Use `sb_set(x, ...)` if `x` is an atomic object (i.e. [mutable\\_atomic](#)).

Use `sb2_set(x, ...)` if `x` is a recursive object (i.e. [data.table](#)).

## Usage

```
sb_set(x, ...)
```

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

```
sb_set(
  x,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)
```

```
## S3 method for class 'matrix'
```

```
sb_set(
  x,
  row = NULL,
  col = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)
```

```
## S3 method for class 'array'
```

```
sb_set(
  x,
  sub = NULL,
  dims = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)
```

```

)

sb2_set(x, ...)

## Default S3 method:
sb2_set(x, ...)

## S3 method for class 'data.table'
sb2_set(
  x,
  row = NULL,
  col = NULL,
  filter = NULL,
  vars = NULL,
  inv = FALSE,
  ...,
  rp,
  tf,
  chkdup = getOption("squarebrackets.chkdup", FALSE),
  .lapply = lapply
)

```

## Arguments

`x` a **variable** belonging to one of the [supported mutable classes](#).

`...` see [squarebrackets\\_method\\_dispatch](#).

`i, row, col, sub, dims, filter, vars, inv`  
 See [squarebrackets\\_idx\\_args](#).  
 An empty index selection leaves the original object unchanged.

`rp, tf, .lapply` see [squarebrackets\\_modify](#).

`chkdup` see [squarebrackets\\_options](#).  
 for performance: set to `FALSE`

## Details

### Transform or Replace

Specifying argument `tf` will transform the subset. Specifying `rp` will replace the subset. One cannot specify both `tf` and `rp`. It's either one set or the other.

## Value

Returns: `VOID`. This method modifies the object by reference.  
 Do not use assignments like `x <- sb_set(x, ...)`.  
 Since this function returns void, you'll just get `NULL`.

## Examples

```
# mutable_atomic objects ===

gen_mat <- function() {
  obj <- as.mutable_atomic(matrix(1:16, ncol = 4))
  colnames(obj) <- c("a", "b", "c", "a")
  return(obj)
}

obj <- obj2 <- gen_mat()
obj
sb_set(obj, 1:3, 1:3, rp = -1:-9)
obj2
obj <- obj2 <- gen_mat()
obj
sb_set(obj, i = \(\x)x<=5, rp = -1:-5)
obj2
obj <- obj2 <- gen_mat()
obj
sb_set(obj, col = "a", rp = cbind(-1:-4, -5:-8))
obj2

obj <- obj2 <- gen_mat()
obj
sb_set(obj, 1:3, 1:3, tf = \(\x) -x)
obj2
obj <- obj2 <- gen_mat()
obj
sb_set(obj, i = \(\x)x<=5, tf = \(\x) -x)
obj2
obj <- obj2 <- gen_mat()
obj
sb_set(obj, col = "a", tf = \(\x) -x)
obj2

gen_array <- function() {
  as.mutable_atomic(array(1:64, c(4,4,3)))
}
obj <- gen_array()
obj
sb_set(obj, list(1:3, 1:2, c(1, 3)), 1:3, rp = -1:-12)
obj
obj <- gen_array()
obj
sb_set(obj, i = \(\x)x<=5, rp = -1:-5)
obj

#####

# data.table ===

obj <- data.table::data.table(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
```



```

sb2_set(
  obj, filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # WARNING: sqrt() results in `dbl`, but columns are `int`, so decimals lost
)
print(obj)

obj <- data.table::data.table(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
dt_setcoe(obj, vars = is.numeric, v = as.numeric)
str(obj)
sb2_set(obj,
  filter = ~ (a >= 2) & (c <= 17), vars = is.numeric,
  tf = sqrt # SAFE: coercion performed by dt_setcoe(); so no warnings
)
print(obj)

obj <- data.table::data.table(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
str(obj) # notice that columns "a" and "c" are INTEGER (`int`)
sb2_set(
  obj, vars = is.numeric,
  tf = sqrt # SAFE: row=NULL & filter = NULL, so coercion performed
)
str(obj)

```

---

sb\_x

---

*Method to Extract, Exchange, or Duplicate Subsets of an Object*


---

## Description

This is an S3 Method to extract, exchange, or duplicate (i.e. repeat x times) subsets of an object.

Use `sb_x(x, ...)` if x is an atomic object.

Use `sb2_x(x, ...)` if x is a recursive object (i.e. list or data.frame-like).

## Usage

```

sb_x(x, ...)

## Default S3 method:
sb_x(x, i = NULL, ...)

## S3 method for class 'matrix'
sb_x(x, row = NULL, col = NULL, i = NULL, ...)

## S3 method for class 'array'
sb_x(x, sub = NULL, dims = NULL, i = NULL, ...)

sb2_x(x, ...)

## Default S3 method:
sb2_x(x, i = NULL, red = FALSE, ...)

```

```
## S3 method for class 'matrix'
sb2_x(x, row = NULL, col = NULL, i = NULL, red = FALSE, ...)

## S3 method for class 'array'
sb2_x(x, sub = NULL, dims = NULL, i = NULL, red = FALSE, ...)

## S3 method for class 'data.frame'
sb2_x(x, row = NULL, col = NULL, filter = NULL, vars = NULL, ...)
```

## Arguments

**x**                    see [squarebrackets\\_supported\\_structures](#).

**...**                see [squarebrackets\\_method\\_dispatch](#).

**i, row, col, sub, dims, filter, vars**  
                       See [squarebrackets\\_indx\\_args](#).  
                       Duplicates are allowed, resulting in duplicated indices.  
                       An empty index selection results in an empty object of length 0.

**red**                 Boolean, for lists only, indicating if the result should be reduced.  
                       If red = TRUE, selecting a single element with non-empty arguments will give the simplified result, like using `[[ ]]`.  
                       If red = FALSE, a list is always returned regardless of the number of elements.

## Value

Returns a copy of the sub-setted object.

## Examples

```
# atomic objects ====

obj <- matrix(1:16, ncol = 4)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb_x(obj, 1:3, 1:3)
# above is equivalent to obj[1:3, 1:3, drop = FALSE]
sb_x(obj, i = \ (x)x>5)
# above is equivalent to obj[obj > 5]
sb_x(obj, col = c("a", "a"))
# above is equivalent to obj[, lapply(c("a", "a"), \ (i) which(colnames(obj) == i)) |> unlist()]

obj <- array(1:64, c(4,4,3))
print(obj)
sb_x(obj, n(1:3, 1:2), c(1,3))
# above is equivalent to obj[1:3, , 1:2, drop = FALSE]
sb_x(obj, i = \ (x)x>5)
# above is equivalent to obj[obj > 5]

#####

# lists ====
```

```

obj <- list(a = 1:10, b = letters[1:11], c = 11:20)
print(obj)
sb2_x(obj, 1) # obj[1]
sb2_x(obj, 1, red = TRUE) # obj[[1]]
sb2_x(obj, 1:2) # obj[1:2]
sb2_x(obj, is.numeric) # obj[sapply(obj, is.numeric)]
# for recursive subsets, see sb2_rec()

#####

# dimensional lists ====

obj <- rbind(
  lapply(1:4, \(x)sample(c(TRUE, FALSE, NA))),
  lapply(1:4, \(x)sample(1:10)),
  lapply(1:4, \(x)rnorm(10)),
  lapply(1:4, \(x)sample(letters))
)
colnames(obj) <- c("a", "b", "c", "a")
print(obj)
sb2_x(obj, 1:3, 1:3)
# above is equivalent to obj[1:3, 1:3, drop = FALSE]
sb2_x(obj, i = is.numeric)
# above is equivalent to obj[sapply(obj, is.numeric)]
sb2_x(obj, col = c("a", "a"))
# above is equivalent to obj[, lapply(c("a", "a"), \(i) which(colnames(obj) == i)) |> unlist()]

obj <- array(as.list(1:64), c(4,4,3))
print(obj)
sb2_x(obj, n(1:3, 1:2), c(1,3))
# above is equivalent to obj[1:3, , 1:2, drop = FALSE]
sb2_x(obj, i = \(x)x>5)
# above is equivalent to obj[sapply(obj, \(x) x > 5)]

#####

# data.frame-like objects ====

obj <- data.frame(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
print(obj)
sb2_x(obj, 1:3, 1:3) # obj[1:3, 1:3, drop = FALSE]
sb2_x(obj, filter = ~ (a > 5) & (c < 19), vars = is.numeric)

```

## Description

The `setapply()` function applies a functions over the rows or columns of a `mutable_atomic` matrix, through [pass-by-reference semantics](#).

For every iteration, a copy of only a single row or column (depending on the margin) is made, the function is applied on the copy, and the original row/column is replaced by the modified copy through [pass-by-reference semantics](#).

The `setapply()` is a bit faster and uses less memory than [apply](#).

## Usage

```
setapply(x, MARGIN, FUN)
```

## Arguments

x	a <a href="#">mutable_atomic</a> matrix. Arrays are not supported.
MARGIN	a single integer scalar, giving the subscript to apply the function over. 1 indicates rows, 2 indicates columns.
FUN	the function to be applied. The function must return a vector of the same type of x, and the appropriate length (i.e. <code>length ncol(x)</code> when <code>MARGIN == 1</code> or <code>length nrow(x)</code> when <code>MARGIN == 2</code> ).

## Value

Returns: VOID. This function modifies the object by reference.  
Do NOT use assignment like `x <- setapply(x, ...)`.  
Since this function returns void, you'll just get NULL.

## Examples

```
# re-order elements matrix by reference ====
x <- mutable_atomic(1:20, dim = c(5,4))
print(x)
setapply(x, 1, FUN = \(x)x[c(4,1,3,2)])
print(x)

# sort elements of matrix by reference ====
x <- mutable_atomic(20:1, dim = c(5,4))
print(x)
setapply(x, 2, FUN = sort)
print(x)
```

## Description

The `slice_` - methods are similar to the `sb_` - methods, except they don't require an indexing vector, and are designed for memory efficiency.

## Usage

```
slice_x(x, ...)

## Default S3 method:
slice_x(x, from = NULL, to = NULL, by = 1L, ..., use.names = TRUE)

slice_rm(x, ...)

## Default S3 method:
slice_rm(x, from = NULL, to = NULL, by = 1L, ..., use.names = TRUE)

slice_set(x, ...)

## Default S3 method:
slice_set(x, from = NULL, to = NULL, by = 1L, inv = FALSE, ..., rp, tf)
```

## Arguments

<code>x</code>	an atomic object. For <code>slice_set</code> it must be a <a href="#">mutable_atomic variable</a> .
<code>...</code>	see <a href="#">squarebrackets_method_dispatch</a> .
<code>from, to, by</code>	see <a href="#">cp_seq</a> .
<code>use.names</code>	Boolean, indicating if flat names should be preserved. Note that, since <code>slice</code> operates on flat indices only, dimensions and dimnames are always dropped.
<code>inv</code>	Boolean, indicating whether to invert the sequence. If TRUE, <code>slice_set()</code> will apply replacement/transformation on all elements of the vector, <b>except</b> for the elements of the specified sequence.
<code>rp, tf</code>	see <a href="#">squarebrackets_modify</a> .

## Value

Similar to the `sb_` methods.

## Examples

```
x <- mutable_atomic(1:1e7)
```

```
# extract:
slice_x(x, 1, 10)

# reverse:
slice_x(x, -1i, 1) |> head()

# remove:
slice_rm(x, 1, -11i) # all elements except the last 10

# replace every other element:
x <- mutable_atomic(1:1e7)
slice_set(x, 2, -1i, 2, rp = -1)
head(x)

# replace all elements except the first element:
x <- mutable_atomic(1:1e7)
slice_set(x, 1, 1, inv = TRUE, rp = -1)
head(x)
```

---

sub2ind

---

*Convert Subscripts to Coordinates, Coordinates to Flat Indices, and Vice-Versa*


---

## Description

These functions convert a list of integer subscripts to an integer matrix of coordinates, an integer matrix of coordinates to an integer vector of flat indices, and vice-versa. Inspired by the sub2ind function from 'MatLab'.

- sub2coord() converts a list of integer subscripts to an integer matrix of coordinates.
- coord2ind() converts an integer matrix of coordinates to an integer vector of flat indices.
- ind2coord() converts an integer vector of flat indices to an integer matrix of coordinates.
- coord2sub() converts an integer matrix of coordinates to a list of integer subscripts; it performs a very simple (one might even say naive) conversion.
- sub2ind() is a faster and more memory efficient version of coord2ind(sub2coord(sub, x.dims), x.dims) (especially for up to 8 dimensions).

All of these functions are written to be memory-efficient.

The coord2ind() is thus the opposite of [arrayInd](#), and ind2coord is merely a convenient wrapper around [arrayInd](#).

Note that the equivalent to the sub2ind function from 'MatLab' is actually the coord2ind() function here.

**Usage**

```

sub2coord(sub, x.dim)

coord2sub(coord)

coord2ind(coord, x.dim, checks = TRUE)

ind2coord(ind, x.dim)

sub2ind(sub, x.dim, checks = TRUE)

```

**Arguments**

sub	<p>a list of integer subscripts.</p> <p>The first element of the list corresponds to the first dimension (rows), the second element to the second dimensions (columns), etc.</p> <p>The length of sub must be equal to the length of x.dim.</p> <p>One cannot give an empty subscript; instead fill in something like seq_len(dim(x)[margin]).</p> <p>NOTE: The coord2sub() function does not support duplicate subscripts.</p>
x.dim	an integer vector giving the dimensions of the array in question. I.e. dim(x).
coord	<p>an integer matrix, giving the coordinate indices (subscripts) to convert.</p> <p>Each row is an index, and each column is the dimension.</p> <p>The first columns corresponds to the first dimension, the second column to the second dimensions, etc.</p> <p>The number of columns of coord must be equal to the length of x.dim.</p>
checks	<p>Boolean, indicating if arguments checks should be performed.</p> <p>Defaults to TRUE.</p> <p>Can be set to FALSE for minor speed improvements.</p> <p><a href="#">for performance: set to FALSE</a></p>
ind	an integer vector, giving the flat position indices to convert.

**Details**

Subscripts and coordinates only exist for dimensional objects (such as arrays). Flat indices (or just "indices" for non-dimensional objects) exist for all objects (in data.frame-like objects, flat indices are actually equal to column indices). Thus flat indices are the "default" indices.

The base S3 vector classes in 'R' use the standard Linear Algebraic convention, as in academic fields like Mathematics and Statistics, in the following sense:

- vectors are **column** vectors (i.e. vertically aligned vectors);
- index counting starts at 1;
- rows are the first dimension/subscript, columns are the second dimension/subscript, etc.

Thus, the orientation of flat indices in, for example, a 4 by 4 matrix, is as follows:

	[,1]	[,2]	[,3]	[,4]
[1,]	1	5	9	13
[2,]	2	6	10	14
[3,]	3	7	11	15
[4,]	4	8	12	16

The subscript [1,2] refers to the first row and the second column. In a 4 by 4 matrix, subscript [1,2] corresponds to flat index 5.

The functions described here thus follow also this convention.

### Value

For sub2coord() and ind2coord():

Returns an integer matrix of coordinates (with properties as described in argument coord).

For coord2ind():

Returns an integer vector of flat indices (with properties as described in argument ind).

For coord2sub():

Returns a list of integer subscripts (with properties as described in argument sub)

### Note

These functions were not specifically designed for duplicate indices per-sé.  
For efficiency, they do not check for duplicate indices either.

### Examples

```
x.dim <- c(10, 10, 3)
x.len <- prod(x.dim)
x <- array(1:x.len, x.dim)
sub <- list(c(4, 3), c(3, 2), c(2, 3))
coord <- sub2coord(sub, x.dim)
print(coord)
ind <- coord2ind(coord, x.dim)
print(ind)
all(x[ind] == c(x[c(4, 3), c(3, 2), c(2, 3)])) # TRUE
coord2 <- ind2coord(ind, x.dim)
print(coord2)
all(coord == coord2) # TRUE
sub2 <- coord2sub(coord2)
sapply(1:3, \i) sub2[[i]] == sub[[i]] |> all() # TRUE
```



tci\_bool

*Type Cast Indices***Description**

These functions typecast indices to proper integer indices.

**Usage**

```
tci_bool(indx, n, inv = FALSE, .abortcall = sys.call())
```

```
tci_int(indx, n, inv = FALSE, chkdup = FALSE, .abortcall = sys.call())
```

```
tci_chr(
  indx,
  nms,
  inv = FALSE,
  chkdup = FALSE,
  uniquely_named = FALSE,
  .abortcall = sys.call()
)
```

```
tci_cplx(indx, n, inv = FALSE, chkdup = FALSE, .abortcall = sys.call())
```

**Arguments**

- |                |   |
|----------------|---|
| indx           | the indices to typecast   |
| n              | the relevant size, when typecasting integer or logical indices.<br>Examples: <ul style="list-style-type: none"> <li>• If the target is row indices, input nrow for n.</li> <li>• If the target is flat indices, input the length for n.</li> </ul>  |
| inv            | Boolean, indicating if the indices should be inverted.<br>See <a href="#">squarebrackets_indx_args</a> .  |
| .abortcall     | environment where the error message is passed to.   |
| chkdup         | see <a href="#">squarebrackets_options</a> .<br>for performance: set to FALSE   |
| nms            | the relevant names, when typecasting character indices.<br>Examples: <ul style="list-style-type: none"> <li>• If the target is row indices, input row names for nms.</li> <li>• If the target is flat indices, input flat names for nms.</li> </ul> |
| uniquely_named | Boolean, indicating if the user knows a-priori that the relevant names of x are unique.<br>If set to TRUE, speed may increase.<br>But specifying TRUE when the relevant names are not unique will result in incorrect output.                       |

**Value**

An integer vector of casted indices.

**Examples**

```
x <- matrix(1:25, 5, 5)
colnames(x) <- c("a", "a", "b", "c", "d")
print(x)

bool <- sample(c(TRUE, FALSE), 5, TRUE)
int <- 1:4
chr <- c("a", "a")
cplx <- 1:4 * -1i
tci_bool(bool, nrow(x))
tci_int(int, ncol(x), inv = TRUE)
tci_chr(chr, colnames(x))
tci_cplx(cplx, nrow(x))

ci_flat(x, 1:10 * -1i)
ci_margin(x, 1:4, 2)
ci_sub(x, n(1:5 * -1i, 1:4), 1:2)
```

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