Package 'squarebrackets'

May 24, 2024

Type Package

Title Subset Methods as an Alternative to the Square Brackets Operators

Version 0.0.0.9

Date 2024-05-07

Description Provides subset methods
(supporting both non-recursive 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 rulesets for data.frame-like types
(data.frames, tibbles, data.tables, tibbles, etc.).
The 'squarebrackets' methods use consistent methods for these 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 `[<-` 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.

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Encoding UTF-8

LinkingTo Rcpp

Roxygen list(markdown = TRUE)

RoxygenNote 7.3.1

Suggests rlang,
knitr,
rmarkdown,
tinytest,
tinycodet,
tidytable,
tibble,
ggplot2,
sf,

future.apply,
collections,
fastmap

Depends R (>= 4.2.0)

Imports Rcpp (>= 1.0.11),
collapse (>= 2.0.2),
data.table (>= 1.14.8),
stringi (>= 1.7.12),
abind (>= 1.4.5)

URL https://github.com/tony-aw/squarebrackets/, https://tony-aw.github.io/squarebrackets/

BugReports https://github.com/tony-aw/squarebrackets/issues/

Language en-gb

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Description

squarebrackets: Methods as an Alternative to the Square Brackets Operators

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 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 **deep copy**.
- **Careful handling of names and other attributes**:

  - Sub-setting an object by index names returns ALL indices with that name, not just the first.
  - Data.frame-like objects (see supported classes below) are forced to have unique column names.
  - Attributes of data.frame-like objects (see supported classes below) are always preserved when sub-setting.
  - For other object types, the user can specify whether to preserve Attributes, or use R's `[` attribute behaviour (i.e. drop most attributes).
    This is to ensure compatibility with R-packages that create their own attribute behaviour for sub-setting.

- **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 S3 classes, and only those that primarily use square brackets for sub-setting (hence the name of the package).

Supported immutable classes:
`atomic`, `factor`, `list`, `data.frame` (including `tibble` and `sf-data.frame`).

Supported mutable classes:
mutable_atomic, `data.table` (including `tidytable` and `sf-data.table`).

There are, of course, a lot of classes which are not supported by 'squarebrackets'.
Most notably, key-value stores, such as environments, or the various 'collections' classes from the 'collections' package, are not supported.

Methods and Functions

GENERIC METHODS
The main focus of this package is on its generic methods.

Generic methods for non-recursive objects (atomic, factor, etc.) start with `sb_`.
Generic methods for recursive objects (list, data.frame, etc.) start with `sb2_`.
There is also the somewhat separate idx method, which works on both recursive and non-recursive objects.

The available generic methods are the following:

- sb_x, sb2_x: extract, exchange, or duplicate subsets.
- sb_rm, sb2_rm: un-select/remove subsets.
- sb_set, sb2_set: modify (transform or replace) subsets of a mutable object using pass-by-reference semantics.
- sb_mod, sb2_mod: return a **copy** of an object with modified (transformed or replaced) subsets.

- sb2_coe: Coercively transform subsets of recursive objects.
- sb_before, sb_after, sb2_before, sb2_after: insert new values before or after an index along a dimension of an object.
- sb2_rec: access recursive subsets of lists.
- sb_setRename, sb2_setRename: change the names of a mutable object using pass-by-reference semantics.
- idx: translate given indices/subscripts, for the purpose of copy-on-modify substitution.

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

SPECIALIZED FUNCTIONS

Additional specialized sub-setting functions are provided:

- 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.
- The dt_-functions for `data.table`-specific `[`-operations.
- sb_str: extract or replace a subset of characters of a single string (each single character is treated as a single element).
- sb_a: extract multiple attributes from an object.

HELPER FUNCTIONS

And finally, a couple of 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 share the same address as the input variable.
- n: Nested version of c, and short-hand for list.
- 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_by to compute grouped indices.
  idx_ord_-functions to compute ordered indices.
- Computing sequences:
  seq_rec2 for the recursive sequence generator (for example to generate a Fibonacci sequence).
  seq_names to create a range of indices from a specified starting and ending name.

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References

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

`aaa1_squarebrackets_immutable_classes`
Supported Immutable S3 Classes, With Auto-Coercion Rules

Description

The `sb_` generic methods support the following immutable S3 classes:

- `atomic` classes
  (atomic vectors, matrices, and arrays);
- factor;
- list - including dimensional lists
  (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`)

Note that "immutable" does not mean you cannot modify it.
It simply means that modification leads to a copy being made.

Auto-Coercion Rules

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`.

Factor

coercion_through_copy: NO
Factors only accept values that are part of their levels, and thus do not support coercion on modification. There is no mechanism for changing factors by reference at all.
Replacing a value with a new value not part of its levels, will result in the replacement value being `NA`.

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()`).

Examples

```
# Coercion examples - lists ====
x <- list(factor(letters), factor(letters))
print(x)
sb2_mod(x, 1, rp = list(1)) # first element fully changed.

x <- list(1:10, 1:10)
print(x)
sb2_rec(x, 1, rp = "a") # coerces first element to character
print(x)


################################################################################


# Coercion examples - data.frame-like - 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
)

################################################################################


# Coercion examples - data.frame-like - partial columns ====

# sb_mod():
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
)
```

`aaa2_squarebrackets_mutable_classes`

Supported Mutable S3 classes, With Auto-Coercion Rules

Description

The `sb_` generic methods support the following Mutable S3 classes:

- mutable_atomic (this vector class supports any dimension, thus also matrices and arrays);
- data.table (including the classes `tidytable` and `sf-data.table`);
- **Views of Lists**: Though lists themselves are treated as immutable, lists can contain mutable objects, and so modification by reference of mutable views of lists **is** support by 'squarebrackets'.

The mutable version of the `list` class would be the environment class, and the various key-value storage classes available in other packages, such as the 'collapse' package.
Key-value storage classes generally do not use square brackets for their primary sub-setting method,

and are thus not covered by this package.

Auto-Coercion Rules

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 **deep 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.
Note that the sb_before and sb_after methods usually allow coercion for all classes.

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 list subset is a data.table, mutable matrix, coercion rules of data.tables apply.
And if the list subset is a data.table, coercion rules of mutable 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)
obj <- sb2_coe(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 sb_coe(); 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 6 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.
- `idx, dims`: to specify indices of arbitrary dimensions in arrays.
- `rcl`: to specify rows (first dimension), columns (second dimension), and layers (third dimension), in arrays that have exactly 3 dimensions.
- `lvl`: specify levels, for factors only.
- `filter, vars`: to specify rows and/or columns specifically in data.frame-like objects.

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

Argument i

class: atomic vector
class: factor
class: recursive vector

Any of the following can be specified for argument `i`:

- `NULL`, only for multi-dimensional objects or factors, when specifying the other arguments (i.e. dimensional indices or factor levels.)
- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).

- a **strictly positive integer** vector with indices.
- a **logical vector** (without NAs!), 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 lists, `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]
```

For a brief explanation of the relationship between flat indices (`i`), and the dimension indices (`row`, `col`, etc.), see the `Details` section in sub2ind.

Arguments row, col

class: atomic matrix
class: data.frame-like

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

- `NULL` (default), corresponds to a missing argument, which results in ALL of the indices in this dimension being selected for the operation.
- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).
- a **strictly positive integer** vector with dimension indices to select for the operation.
- a **logical** vector (without NAs!) 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 an object 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]
```

Arguments idx, dims

class: atomic array
class: recursive array

idx must be a list of indices.
dims must be an integer vector of the same length as idx, giving the dimensions to which the indices given in idx correspond to.
The elements of idx follow the same rules as the rules for row and col, EXCEPT one should not fill in NULL.
NOTE: The arguments idx and dims will be ignored if i is specified.

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

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

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

Arguments rcl

class: atomic array

The rcl argument is only applicable for atomic arrays with exactly 3 dimensions.
If the user knows a-priori that an array has 3 dimensions, using rcl is more efficient than using the idx, dims arguments.

The rcl argument must be a list of exactly 3 elements, with the first element giving the indices of the first dimension (rows), the second element giving the indices of the second dimension (columns), and the third element giving the indices of the third and last dimension (layers); thus rcl stands for "rows, columns, layers" (i.e. the 3 dimensions of a 3-dimensional array).
For each of the aforementioned 3 elements of the list rcl, any of the following can be specified:

- NULL, corresponds to a missing argument, which results in ALL of the indices in this dimension being selected for the operation.
- a vector of length 0, in which case no indices are selected for the operation (i.e. empty selection).
- a **strictly positive integer** vector with dimension indices to select for the operation.
- a **logical** vector (without NAs!) 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 an object has multiple indices with the given name, ALL the corresponding indices will be selected for the operation.

By default rcl is not a list but simply NULL, to be used when specifying the other arguments (either idx, dims or i).

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

Using the rcl argument corresponds to doing something like the following:

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

Argument lvl

class: factor

For this argument, the names of the levels of `x` can be given, selecting the corresponding indices for the operation.

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 inv

all classes

Relevant for sb_mod, sb_set, sb2_coe, and idx.
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, 1:2, 1:2, tf = tf)` corresponds to something like the following:

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

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

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

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 `NA`s 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.
The arguments are evaluated in the following order:

1. Argument `i`
2. Argument `lvl` (for factors) or argument `rcl` (for 3-dimensional arrays)
3. The rest of the indexing arguments.

One cannot specify `row` and `filter` simultaneously. It's either one or the other. Similarly, one cannot specify `col` and `vars` simultaneously.
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, idx, 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]
```

First, Last, and Shuffle

The indices are counted forward. I.e. `1` is the first element, not the last.
One can use the last function to get the last `N` indices.

One can use the first function to get the first `N` indices.

To shuffle elements of indices, use the sample function.

Regarding Performance

Integer indices and logical indices are the fastest.
Indexing through names or levens (i.e. character vectors) is the slowest.
Thus if performance is important, use integer or logical indices.

`aaa4_squarebrackets_duplicates`
On Duplicates

Description

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.

`aaa5_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.
But at least 2 things should be taken into consideration when modifying an object by reference.

First, the coercion rules are slightly different: see squarebrackets_mutable_classes.

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 types

With the exception of environments, most of base R's data types are treated as immutable:
Modifying an object in 'R' will make a copy of the object, something called 'copy-on-modify' semantics.
However, almost any of base R's datatypes can be modified by reference, through R's own 'C' API, or through 'C++' code (like via 'Rcpp'), thus treating these objects as mutable, even though they are not "supposed" to be mutable.
Modifying a base 'R' object by reference can be problematic.
Since 'R', and also most R-packages, treat these objects as immutable, modifying them as-if they are mutable may produce undesired results.

To prevent the issue described above, 'squarebrackets' only supports pass-by-reference semantics on objects that are actually supposed to be mutable.
In relation to this restriction, 'squarebrackets' adds a new class of objects, mutable_atomic, which are simply atomic objects that have the permission to be modified by reference.

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.

For example:

- A `data.table` is a mutable class.
  So all columns of the `data.table` are treated as mutable;
  There is no requirement, for example, to first change all columns into the class of mutable_atomic to modify them by reference.

- A regular `list` is an immutable class.
  The contents of the list therefore retain their mutability.
  So if a mutable object, such as a mutable_atomic object or a `data.table`, is a subset of a list, the view of that list subset can be modified by reference, even though the list as a whole is immutable.

Views of Lists

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`.

Input Variable

Methods/functions that perform in-place modification by reference can be thought of as similar to functions in the style of `some_function(x, ...) <- value`, in the sense that the variable must actually exist as an actual variable.
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 currentBindings 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.

Protected Addresses

To prevent an accidental pass-by-reference modification of objects in the base environment, all addresses of all exported objects in the base environment (baseenv) are stored in the option `squarebrackets.protected` whenever 'squarebrackets' is **loaded**, either directly or indirectly.
Needless to say, the user should never touch this option.

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.

Some packages provide functions that change class-related attributes of objects by reference.
Using such functions is discouraged, unless you know exactly what you're doing.

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

# Word of warning:
# the safe-guard in 'squarebrackets' is good, but definitely not perfect.
# Do not actively try to break things; you might actually succeed.
```

---

aaa6_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.

Array with Unknown Number of Dimensions

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 the 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.

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.

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.

`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: sb_set accepts `mutable_atomic`, but does not accept regular `atomic`.
See squarebrackets_PassByReference for details.

Like `data.table`, `[<-` performs R's default copy-on-modification semantics.
For modification by reference, use sb_set.

Exposed functions (besides the S3 methods):

- `is.mutable_atomic()`: checks if an object is atomic.
- `as.mutable_atomic()`: converts a regular atomic object to `mutable_atomic`.

- `couldb.mutable_atomic()`: checks if an object could be `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.

Usage

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

as.mutable_atomic(x, ...)

is.mutable_atomic(x)

couldb.mutable_atomic(x)

## 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

`data`	atomic vector giving data to fill the `mutable_atomic` object.
`names`, `dim`, `dimnames`	see setNames and array.
`x`	an atomic object.
`...`	method dependent arguments.
`value`	see Extract.

Value

For `as.mutable_atomic`:
Converts an atomic object (vector, matrix, array) to the same object, but with additional class `"mutable_atomic"`, and the additional attribute `"typeof"`.

For `is.mutable_atomic`:
Returns `TRUE` if the object is atomic, has the class `"mutable_atomic"`, has the correctly set attribute `"typeof"`, **and** has an address that does not overlap with the addresses of base objects.
`is.mutable_atomic` 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 mutable_atomic() or as.mutable_atomic to create a mutable 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

x <- matrix(1:10, ncol = 2)
x <- as.mutable_atomic(x)
is.mutable_atomic(x)
print(x)
x[, 1]
x[] <- as.double(x) # notifies the user a copy is being made
print(x) # "typeof" attribute adjusted accordingly, and class still present
```

---

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: • "list" (default). • "checklock". • "lockbindings".
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 **caller 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.

- `dt_aggregate()` aggregates a data.table or tidytable, and returns the aggregated copy.
- `dt_setcoe()` 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()` reorder 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_setcoe(
  x,
  col = NULL,
  vars = NULL,
  v,
  chkdup = getOption("sb.chkdup", FALSE)
)

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

dt_setadd(x, new)

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

Arguments

`x`	a `data.table` or `tidytable`.
`SDcols`	atomic vector, giving the columns to which the aggregation function `f()` is to be applied on.

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

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, idx = idx, 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 `idx, 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, idx, 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 deep copy semantics and pass-by-reference 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,
  idx = 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.
...	further arguments passed to or from other methods.
i, idx, dims, inv	See squarebrackets_indx_args. Duplicates are not allowed.
chkdup	see squarebrackets_duplicates. for performance: set to FALSE
slice	see arguments row and col in squarebrackets_indx_args.
margin	a single integer, specifying the dimension for slice.

Value

A vector of strictly positive integer indices.

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`;
- the complete range of indices `r` of some object `x`;
- and a grouping factor `grp`;

the `idx_by()` function takes indices `f(r)` **per group** `grp`.
The result of `idx_by()` can be supplied to the indexing arguments (see squarebrackets_indx_args) of:
sb_x/sb2_x, sb_rm/sb2_rm, sb_mod/sb2_mod, sb_set/sb2_set, or sb2_coe,

to perform **grouped** subset operations.

Usage

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

Arguments

`f`	a subset function to be applied per group on `r`. The function must accept a character or integer vector as input, and produce a character or integer vector as output. For example, to subset the last element per group, specify: `f = last`
`r`	an integer or character vector, giving the complete range of indices of an object. For example: `colnames(x)`, `1:nrow(x)`, etc.
`grp`	a factor giving the groups. Make sure its order corresponds to `i` and `r`, otherwise it makes no sense.
`parallel`, `mc.cores`	see BY.

Value

A vector of indices of the same type as `r`.

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(last, seq_along(a), 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(first, 1:nrow(x), x$group)
sb2_x(x, row)
# get the first row for each group for which a > 10:
x2 <- sb2_x(x, filter = ~ a > 10)
row <- na.omit(idx_by(first, 1:nrow(x2), x2$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 a 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

`x`	a vector, data.frame, or array
`na.last`, `method`	see order and sort.

decr	see argument decreasing in order
margin	the margin over which to cut the matrix/array into vectors. I.e. margin = 1 will cut x into individual rows, and apply the order on those rows. And margin = 2 will cut x 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))
```

---

indx_x *Exported Utilities*

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))
```

`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))`, `NA`s 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 vector (`TRUE`, default), or a list (`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` *Find and Replace Present Values in mutable_atomic Objects By Reference*

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

`x`	a mutable_atomic **variable**.
`v`	non-missing (so no `NA` or `NaN`) atomic scalar to find.
`rp`	atomic scalar giving the replacement value.
`invert`	Boolean. If `FALSE` (default), the equivalent of `x[which(x == v()] <- rp` is performed; If `TRUE`, the equivalent of `x[which(x != v)] <- rp` is performed instead.
`NA.safety`	Boolean. just like in which, `NA` and `NaN` results in `x==v` should be ignored, thus `NA.safety` is `TRUE` by default. However, if it is known that `x` contains no `NA`s or `NaN`s, setting `NA.safety` to `FALSE` will increase performance a bit. NOTE: Setting `NA.safety = FALSE` when `x` does contain `NA`s or `NaN`s, 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 *Nest*

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 **nests** 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]
```

sb2_coe *Method to Coercively Transform Subsets of Recursive Objects*

Description

This is an S3 Method to completely transform subsets of recursive objects with explicit coercion.

Note that when `x` is a `data.table`, one can coercively transform columns by reference (which is more memory efficient), using dt_setcoe.

Usage

```
sb2_coe(x, ...)

## Default S3 method:
sb2_coe(x, i, inv = FALSE, ..., v, .lapply = lapply)

## S3 method for class 'array'
sb2_coe(
  x,
  idx = NULL,
  dims = NULL,
  i = NULL,
  inv = FALSE,
  ...,
  v,
  .lapply = lapply
)

## S3 method for class 'data.frame'
sb2_coe(x, col = NULL, vars = NULL, inv = FALSE, ..., v)
```

Arguments

`x`	a recursive object (list-like or data.frame-like).
`...`	further arguments passed to or from other methods.
`i`, `col`, `vars`, `idx`, `dims`, `inv`	See squarebrackets_indx_args. An empty index selection returns the original object unchanged.
`v`	the coercive transformation function to use.
`.lapply`	the generic methods use lapply for list- and data.frame-like objects to compute `tf()` on every list element or dataset column. The user may supply a custom `lapply()`-like function in this argument to use instead. For example, the 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.

Value

A copy of the coercively transformed object.

Examples

```
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]))
obj <- sb2_coe(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; so no warnings
)
print(obj)
```

---

sb2_rec *Access Recursive Subsets*

Description

The `sb2_rec()` method allows the user to access recursive subsets of lists.

The `sb2_rec()` method also allows replacing or transforming a recursive subset of a list, using R's default in-place semantics, by specifying the `rp` argument.

Usage

```
sb2_rec(lst, rec, rp)
```

Arguments

`lst`	a list, or list-like object.
`rec`	a vector of length p, such that `lst[[rec]]` is equivalent to `lst[[ rec[1] ]]...[[ rec[p] ]]`, providing all but the final indexing results in a list. 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 subsetting.
`rp`	optional. If specified, performs `lst[[rec]] <- rp`, using R's default in-place semantics.

Value

If rp is not specified: Returns the recursive subset.
If rp is specified: Returns nothing, but replaces the recursive subset with rp, using R's default in-place 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 with R's default in-place semantics ====

# replace "AAB" using R's default in-place semantics:
sb2_rec(
  lst, c("A", "A", "B"),
  rp = "THIS IS REPLACED WITH IN-PLACE SEMANTICS"
)
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_before *Methods to Insert New Values Before or After an Index Along a Dimension*

Description

The sb_before()/sb2_before() method inserts new values before some position along a dimension.
The sb_after()/sb2_after() method inserts new values after some position along a dimension.

Use sb_before(x, ...)/sb_after(x, ...) if x is a non-recursive object (i.e. atomic or factor).
Use sb2_before(x, ...)/sb2_after(x, ...) if x is a recursive object (i.e. list or data.frame-like).

sb2_before.array() and sb2_after.array() use an altered version of abind::abind (see references below) to work on recursive arrays (i.e. dimensional lists).
It is partially written in 'C++' (via 'Rcpp') and 'C' (via 'collapse'), for better performance.

Usage

```
sb_before(x, ...)

sb_after(x, ...)

## Default S3 method:
sb_before(x, new, pos = 1, .attr = NULL, ...)

## Default S3 method:
sb_after(x, new, pos = length(x), .attr = NULL, ...)

## S3 method for class 'array'
sb_before(x, new, margin, pos = 1, .attr = NULL, ...)

## S3 method for class 'array'
sb_after(x, new, margin, pos = dim(x)[margin], .attr = NULL, ...)

## S3 method for class 'factor'
sb_before(x, new, pos = 1, .attr = NULL, ...)

## S3 method for class 'factor'
sb_after(x, new, pos = length(x), .attr = NULL, ...)

sb2_before(x, ...)

sb2_after(x, ...)
```

```
## Default S3 method:
sb2_before(x, new, pos = 1, .attr = NULL, ...)

## Default S3 method:
sb2_after(x, new, pos = length(x), .attr = NULL, ...)

## S3 method for class 'array'
sb2_before(x, new, margin, pos = 1, .attr = NULL, ...)

## S3 method for class 'array'
sb2_after(x, new, margin, pos = dim(x)[margin], .attr = NULL, ...)

## S3 method for class 'data.frame'
sb2_before(x, new, margin, pos = 1, .attr = NULL, ...)

## S3 method for class 'data.frame'
sb2_after(x, new, margin, pos = collapse::fdim(x)[margin], .attr = NULL, ...)
```

Arguments

x	see squarebrackets_immutable_classes and squarebrackets_mutable_classes.
...	further arguments passed to or from other methods.
new	the new value(s). The type of object depends on x: • For atomic objects, new can be any atomic object. However, if one wished the added values in new to be named, ensure new is the same type of object as x. For example: use matrix with column names for new when appending/inserting columns to matrix x. • For factors, new must be a factor. • For lists, new must be a (possible named) list. • For data.frame-like objects, new must be a data.frame.
pos	a strictly positive single integer scalar (so no duplicates), giving the position along the dimension (specified in margin), before or after which the new values are added.
.attr	a list, giving additional potentially missing attributes to be added to the returned object. By default, concatenation strips attributes, since the attributes of x and new may not be equal or even compatible. In the attr argument, the attributes of the merged object can be specified. Only attributes that are actually missing AFTER insertion will be added, thus preventing overwriting existing attributes like names. One may, for example, specify .attr = sb_a(x) or .attr = sb_a(new). If NULL (the default), no attributes will be added post-insert. If speed is important, NULL is the best option (but then attributes won't be preserved).
margin	a single scalar, giving the dimension along which to add new values.

Value

Returns a copy of the appended 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 objects ====

x <- matrix(1:20 , ncol = 4)
print(x)
new <- -1 * x
sb_before(x, new, 1)
sb_after(x, new, 1)
sb_before(x, new, 2)
sb_after(x, new, 2)


################################################################################


# factors ====

x <- factor(letters)
new <- factor("foo")
sb_before(x, new)
sb_after(x, new)


################################################################################


# lists ====

x <- as.list(1:5)
new <- lapply(x, \(x)x*-1)
print(x)
sb2_before(x, new)
sb2_after(x, new)


################################################################################


# recursive arrays / dimensional lists ====

x <- matrix(c(as.list(1:20), as.list(letters[1:20])) , ncol = 8) |> t()
dimnames(x) <- list(letters[1:8], letters[1:5])
print(x)
new <- matrix(c(as.list(-1:-20), as.list(letters[26:7])) , ncol = 8) |> t()
sb2_before(x, new, 1)
sb2_after(x, new, 1)
sb2_before(x, new, 2)
sb2_after(x, new, 2)
```

```
################################################################################


# data.frame-like objects ====

x <- data.frame(a = 1:10, b = letters[1:10], c = 11:20, d = factor(letters[1:10]))
new <- data.frame(e = 101:110)
sb2_before(x, new, 2)
sb2_after(x, new, 2)
new <- x[1,]
sb2_before(x, new, 1)
sb2_after(x, new, 1)
```

---

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 a non-recursive object (i.e. atomic or factor).
Use `sb2_mod(x, ...)` if `x` is a recursive object (i.e. list or data.frame-like).

For modifying subsets using R's default copy-on-modification semantics, see idx.

Usage

```
sb_mod(x, ...)

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

## S3 method for class 'factor'
sb_mod(
  x,
  i = NULL,
  lvl = NULL,
  inv = FALSE,
  ...,
  rp,
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

sb2_mod(x, ...)

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

## S3 method for class 'array'
sb2_mod(
  x,
  idx = 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 squarebrackets_immutable_classes and squarebrackets_mutable_classes.
...	further arguments passed to or from other methods.
i, lvl, row, col, idx, dims, rcl, filter, vars, inv	See squarebrackets_indx_args. An empty index selection returns the original object unchanged.
rp	an object of somewhat the same type as the selected subset of x, and the same same length as the selected subset of x or a length of 1.
tf	the transformation function.
chkdup	see squarebrackets_duplicates. for performance: set to FALSE
.lapply	the generic methods use lapply for list- and data.frame-like objects to compute tf() on every list element or dataset column. The user may supply a custom lapply()-like function in this argument to use instead. For example, the 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.
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. 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.
Note that the tf argument is not available for factors: this is intentional.

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

################################################################################


# recursive arrays / dimensional lists ====
obj <- c(as.list(1:10), as.list(letters[1:10])) |> array(dim = c(5, 4)) |> t()
print(obj)
sb2_mod(obj, list(1:3), 1, rp = list(FALSE))
# above is equivalent to obj[1:3, ] <- list(FALSE)


################################################################################

# 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 a non-recursive object (i.e. atomic or factor).
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,
  ...,
  rat = getOption("squarebrackets.rat", FALSE),
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

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

## S3 method for class 'array'
sb_rm(
  x,
  idx = NULL,
  dims = NULL,
```

```
  rcl = NULL,
  i = NULL,
  ...,
  rat = getOption("squarebrackets.rat", FALSE),
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

## S3 method for class 'factor'
sb_rm(
  x,
  i = NULL,
  lvl = NULL,
  drop = FALSE,
  ...,
  rat = getOption("squarebrackets.rat", FALSE),
  chkdup = getOption("squarebrackets.chkdup", FALSE)
)

sb2_rm(x, ...)

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

## S3 method for class 'array'
sb2_rm(
  x,
  idx = NULL,
  dims = NULL,
  i = NULL,
  drop = FALSE,
  ...,
  rat = getOption("squarebrackets.rat", 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 squarebrackets_immutable_classes and squarebrackets_mutable_classes.
...	further arguments passed to or from other methods.
i, lvl, row, col, idx, dims, rcl, filter, vars	See squarebrackets_indx_args. An empty index selection results in nothing being removed, and the entire object is returned.
rat	Boolean, indicating if attributes should be returned with the sub-setted object. See Details section for more info. for performance: set to FALSE
chkdup	see squarebrackets_duplicates. for performance: set to FALSE
drop	Boolean. • For factors: If drop = TRUE, unused levels are dropped, if drop = FALSE they are not dropped. • For lists: if drop = TRUE, and sub-setting is done using argument i, selecting a single element will give the simplified result, like using [[]]. If drop = FALSE, a list is always returned regardless of the number of elements.

Details

One the rat argument
Most [- methods strip most (but not all) attributes.
If rat = FALSE, this default behaviour is preserved, for compatibility with special classes. This is the fastest option.
If rat = TRUE, attributes from x missing after sub-setting are re-assigned to x. Already existing attributes after sub-setting will not be overwritten.
There is no rat argument for data.frame-like object: their attributes will always be preserved.
NOTE: In the following situations, the rat argument will be ignored, as the attributes necessarily have to be dropped:

- when x is a list, AND drop = TRUE, AND a single element is selected, AND sub-setting is done through the i argument.
- when x is an atomic matrix or array, and sub-setting is done through the i argument.

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)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))
sb_rm(obj, rcl = n(1, NULL, c(1, 3)))
# above 2 lines are equivalent to obj[-1, c(-1, -3), drop = FALSE]
sb_rm(obj, i = \(x)x>5)
# above is equivalent to obj[!obj > 5]

################################################################################


# factors ====

obj <- factor(rep(letters[1:5], 2))
sb_rm(obj, lvl = "a")
# above is equivalent to obj[which(!obj %in% "a")]


################################################################################


# 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, drop = 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 recusive indexing, see sb2_rec()


################################################################################


# recursive arrays / dimensional lists ====
obj <- c(as.list(1:10), as.list(letters[1:10])) |> array(dim = c(5, 4)) |> t()
print(obj)
sb2_rm(obj, list(1:3), 1)
# above is equivalent to obj[-1:-3, ]


################################################################################
```

```
# 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 a non-recursive 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,
  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,
  idx = NULL,
  dims = NULL,
  rcl = 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.
...	further arguments passed to or from other methods.
i, row, col, idx, dims, rcl, filter, vars, inv	See squarebrackets_indx_args. An empty index selection leaves the original object unchanged.
rp	an object of somewhat the same type as the selected subset of x, and the same same length as the selected subset of x or a length of 1.
tf	the transformation function.
chkdup	see squarebrackets_duplicates. for performance: set to FALSE
.lapply	the generic methods use lapply for list- and data.frame-like objects to compute tf() on every list element or dataset column. The user may supply a custom lapply()-like function in this argument to use

instead.
For example, the 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.

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.
Note that there is no `sb_set()` method for factors: this is intentional.

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]))
obj <- sb2_coe(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 sb_coe(); 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_setRename *Method to Change the Names of a Mutable Object By Reference*

Description

This is an S3 Method to rename a supported mutable object using pass-by-reference semantics.

This method takes extra care not to modify any objects that happen to share the same address

as the (dim)names of x.
I.e. the following code:

```
x <- mutable_atomic(1:26)
names(x) <- base::letters
y <- x
sb_setRename(x, newnames = rev(names(x)))
```

will not modify base::letters, even though names(x) shared the same address.
Thus, sb_setRename() can be used safely without fearing such accidents.

Use sb_setRename(x, ...) if x is a non-recursive object (i.e. mutable_atomic).
Use sb2_setRename(x, ...) if x is a recursive object (i.e. data.table).

Usage

```
sb_setRename(x, ...)

## Default S3 method:
sb_setRename(x, newnames, ...)

## S3 method for class 'array'
sb_setRename(x, newnames, newdimnames, ...)

sb2_setRename(x, ...)

## S3 method for class 'data.table'
sb2_setRename(x, old, new, skip_absent = FALSE, ...)
```

Arguments

x	a **variable** belonging to one of the supported mutable classes.
...	further arguments passed to or from other methods.
newnames	atomic character vector giving the new names. Specifying NULL will remove the names.
newdimnames	a list of the same length as dim(x). The first element of the list corresponds to the first dimension, the second element to the second dimension, and so on. The components of the list can be either NULL, or a character vector with the same length as the corresponding dimension. Instead of a list, simply NULL can be specified, which will remove the dimnames completely.
old	the old column names
new	the new column names, in the same order as old
skip_absent	Skip items in old that are missing (i.e. absent) in names(x). Default FALSE halts with error if any are missing.

Value

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

Examples

```
# mutable atomic vector ====
x <- y <- mutable_atomic(1:10, names = letters[1:10])
sb_setRename(x, rev(letters[1:10]))
print(x)

################################################################################


# mutable atomic matrix ====
x <- mutable_atomic(
  1:20, dim = c(5, 4), dimnames = n(letters[1:5], letters[1:4])
)
print(x)
sb_setRename(
  x,
  newdimnames = lapply(dimnames(x), rev)
)
print(x)


x <- mutable_atomic(
   1:20, letters[1:20], dim = c(5, 4), dimnames = n(letters[1:5], letters[1:4])
)
print(x)
sb_setRename(
  x, newnames = rev(names(x)),
  newdimnames = lapply(dimnames(x), rev)
)
print(x)


################################################################################



# data.table ====

x <- data.table::data.table(
  a = 1:20,
  b = letters[1:20]
)
print(x)
sb2_setRename(x, old = names(x), new = rev(names(x)))
print(x)
```

sb_special *Specialized Sub-setting Functions*

Description

The sb_a() function subsets extracts one or more attributes from an object.

The sb_str() function subsets characters of single string, or replace a subset of the characters of a single string with the subsets of the characters of another string. In both cases, a single string is treated as a iterable vector, where each single character in a string is a single element. The sb_str() function is considerably faster than doing the equivalent operation in base 'R' or even 'stringi'.

Usage

```
sb_str(str, ind, rp.str, rp.ind)

sb_a(x, a = NULL)
```

Arguments

str	a single string.
ind	an integer vector, giving the positions of the string to subset.
rp.str, rp.ind	similar to str and ind, respectively. If not specified, sb_str() will perform something like str[ind] treating str as an iterable vector. If these ARE specified, sb_str() will perform something like str[ind] <- rp.str[rp.ind] treating str and rp.str as iterable vectors.
x	an object
a	a character vector of attribute names. If NULL (default), ALL attributes are returned.

Value

The sub-setted object.

Examples

```
x <- matrix(1:10, ncol = 2)
colnames(x) <- c("a", "b")
attr(x, "test") <- "test"
sb_a(x, "test")
sb_a(x)


x <- "hello"
sb_str(x, 5:1) # this gives "olleh"
```

```
sb_str(x, c(1:5, 5)) # this gives "helloo"
sb_str(x, c(2:5)) # this gives "ello"
sb_str(x, seq(1, 5, by = 2)) # this gives "hlo"
sb_str(x, 1:4, "world", 1:4) # this gives "worlo"
```

---

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 a non-recursive object (i.e. atomic or factor).
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, ..., rat = getOption("squarebrackets.rat", FALSE))

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

## S3 method for class 'array'
sb_x(
  x,
  idx = NULL,
  dims = NULL,
  rcl = NULL,
  i = NULL,
  ...,
  rat = getOption("squarebrackets.rat", FALSE)
)

## S3 method for class 'factor'
sb_x(
  x,
  i = NULL,
  lvl = NULL,
  drop = FALSE,
```

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

sb2_x(x, ...)

## Default S3 method:
sb2_x(x, i, drop = FALSE, ..., rat = getOption("squarebrackets.rat", FALSE))

## S3 method for class 'array'
sb2_x(
  x,
  idx = NULL,
  dims = NULL,
  i = NULL,
  drop = FALSE,
  ...,
  rat = getOption("squarebrackets.rat", FALSE)
)

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

Arguments

`x`	see squarebrackets_immutable_classes and squarebrackets_mutable_classes.
`...`	further arguments passed to or from other methods.
`i`, `lvl`, `row`, `col`, `idx`, `dims`, `rcl`, `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.
`rat`	Boolean, indicating if attributes should be returned with the sub-setted object. See Details section for more info. for performance: set to FALSE
`drop`	Boolean. • For factors: If `drop = TRUE`, unused levels are dropped, if `drop = FALSE` they are not dropped. • For lists: if `drop = TRUE`, and sub-setting is done using argument `i`, selecting a single element will give the simplified result, like using `[[]]`. If `drop = FALSE`, a list is always returned regardless of the number of elements.

Details

One the `rat` argument

Most `[` - methods strip most (but not all) attributes.
If `rat = FALSE`, this default behaviour is preserved, for compatibility with special classes. This is the fastest option.
If `rat = TRUE`, attributes from `x` missing after sub-setting are re-assigned to `x`. Already existing attributes after sub-setting will not be overwritten.

There is no `rat` argument for data.frame-like object: their attributes will always be preserved.
NOTE: In the following situations, the `rat` argument will be ignored, as the attributes necessarily have to be dropped:

- when `x` is a list, AND `drop = TRUE`, AND a single element is selected, AND sub-setting is done through the `i` argument.
- when `x` is an atomic matrix or array, and sub-setting is done through the `i` argument.

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))
sb_x(obj, rcl = n(1:3, NULL, 1:2))
# above 2 lines are equivalent to obj[1:3, , 1:2, drop = FALSE]
sb_x(obj, i = \(x)x>5)
# above is equivalent to obj[obj > 5]

##############################################################################



# factors ====

obj <- factor(rep(letters[1:5], 2))
sb_x(obj, lvl = c("a", "a"))
# above is equivalent to obj[lapply(c("a", "a"), \(i) which(obj == i)) |> unlist()]

##############################################################################


# 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, drop = TRUE) # obj[[1]]
```

```
sb2_x(obj, 1:2) # obj[1:2]
sb2_x(obj, is.numeric) # obj[sapply(obj, is.numeric)]
# for recursive indexing, see sb2_rec()

################################################################################


# recursive arrays / dimensional lists ====
obj <- c(as.list(1:10), as.list(letters[1:10])) |> array(dim = c(5, 4)) |> t()
print(obj)
sb2_x(obj, list(1:3), 1)
# above is equivalent to obj[1:3, ]


################################################################################

# 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)
```

`seq_names` *Generate Integer Sequence From a Range of Names*

Description

Generate integer sequence from a range of names.

Usage

```
seq_names(names, start, end, inv = FALSE)
```

Arguments

`names`	a character vector of names. Duplicate names, empty names, or a character vector of length zero are not allowed.
`start`	the name giving the starting index of the sequence
`end`	the name giving the ending index of the sequence
`inv`	Boolean. If `TRUE`, the indices of all names **except** the names of the specified sequence will be given.

Value

An integer vector.

Examples

```
x <- data.frame(
  a = 1:10, b = letters[1:10], c = factor(letters[1:10]), d = -1:-10
)
ind <- seq_names(colnames(x), "b", "d")
sb2_x(x, col = ind)
```

`seq_rec2` *Generate Recursive Sequence Through Repeated Arithmetic Infix Operations*

Description

This is a recursive sequence generator.
The function is essentially a highly generalized version of a Fibonacci sequence generator.

Starting with 2 initial values, each next value `i` is generated by either one of 2 formulas:

1. `x[i] = (s[1] + m[1] * x[i-1]) %inop% (s[2] + m[2] * x[i-2])`
2. `x[i] = (m[1] * (x[i-1] + s[1])) %inop% (m[2] * (x[i-2] + s[2]))`

where `%inop%` is the arithmetic infix operator chosen,
and `m` and `s` are each a numeric vector of length 2.
The order of `x[i-1]` and `x[i-2]` can also be swapped.

Usage

```
seq_rec2(
  inits = c(0L, 1L),
  n = 10L,
  s = c(0L, 0L),
  m = c(1L, 1L),
  inop = "+",
  form = 1L,
  rev = FALSE
)
```

Arguments

`inits`	a numeric (double or integer) vector of length 2, giving the initial values. Any numbers are allowed, even negative and/or fractional numbers. Note that numbers given must give valid results when passed to function `f()`.
`n`	a single integer, giving the size of the numeric vector to generate. NOTE: it must hold that `n > 2`.
`s, m`	numeric vectors of length 2 to be used in the formula.
`inop`	a single string, giving the arithmetic infix operator to be used. Currently supported: "+", "-", "*", "/". For a fibonacci sequence, `inop = "+"`.

`form` either 1 or 2, indicating which formula to be used (see Description section above).

`rev` reverse the order of `x[i-1]` and `x[-2]`.
For example, using `form = 1`:

- If `rev = FALSE` (default), it holds:
  `x[i] = (s[1] + m[1] * x[i-1]) %inop% (s[2] + m[2] * x[i-2])`.
- If `rev = TRUE`, it holds:
  `x[i] = (s[1] + m[1] * x[i-2]) %inop% (s[2] + m[2] * x[i-1])`

Details

The default values of the arguments give the first 10 numbers of a regular Fibonacci sequence.
See examples for several number series created with this function.
This function is written in C++ using Rcpp for better performance.

Value

A sequence of numbers.

Note

Do not supply NAs or NaNs to this function, as it cannot handle them.

Examples

```
seq_rec2() # by default gives Fibonacci numbers
seq_rec2(inits = 2:1) # Lucas numbers
c(1, seq_rec2(c(1, 2), inop = "*")) # Multiplicative Fibonacci
seq_rec2(m = c(2L, 1L)) # Pell numbers
seq_rec2(inits = c(1, 0), m = c(0L, 2L)) # see https://oeis.org/A077957
seq_rec2(m = c(1L, 2L)) # Jacobsthal numbers
```

---

setapply *Apply Functions Over mutable_atomic Matrix Margins By Reference*

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 mutable_atomic 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. length `ncol(x)` when `MARGIN == 1` or length `nrow(x)` when `MARGIN == 2`).

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)
```

`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 5 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`	a list of integer subscripts. The first element of the list corresponds to the first dimension (rows), the second element to the second dimensions (columns), etc. The length of `sub` must be equal to the length of `x.dim`. One cannot give an empty subscript; instead fill in something like `seq_len(dim(x)[margin])`. NOTE: The `coord2sub()` function does not support duplicate subscripts.
`x.dim`	an integer vector giving the dimensions of the array in question. I.e. `dim(x)`.
`coord`	an integer matrix, giving the coordinate indices (subscripts) to convert. Each row is an index, and each column is the dimension. The first columns corresponds to the first dimension, the second column to the second dimensions, etc.

The number of columns of coord must be equal to the length of x.dim.

checks — Boolean, indicating if arguments checks should be performed.
Defaults to TRUE.
Can be set to FALSE for minor speed improvements.
for performance: set to FALSE

ind — an integer vector, giving the flat position indices to convert.

Details

The S3 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(coord)
all(coord == coord2) # TRUE
sub2 <- coord2sub(coord2)
sapply(1:3, \(i) sub2[[i]] == sub[[i]]) |> all() # TRUE
```

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