Package 'bit'

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Title Classes and Methods for Fast Memory-Efficient Boolean Selections

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Description Provided are classes for boolean and skewed boolean vectors, fast boolean methods, fast unique and non-unique integer sorting, fast set operations on sorted and unsorted sets of integers, and foundations for ff (range index, compression, chunked processing).

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`bit-package` *bit: Classes and methods for fast memory-efficient boolean selections*

Description

Provided are classes for boolean and skewed boolean vectors, fast boolean methods, fast unique and non-unique integer sorting, fast set operations on sorted and unsorted sets of integers, and foundations for ff (range indices, compression, chunked processing).

Details

For details view the `vignette("bit-usage")` and `vignette("bit-performance")`.

`.BITS` *Initializing bit masks*

Description

Functions to allocate (and de-allocate) bit masks

Usage

```
.BITS

bit_init()

bit_done()
```

Format

An object of class `integer` of length 1.

Details

The C-code operates with bit masks. The memory for these is allocated dynamically. `bit_init` is called by `.First.lib()` and `bit_done` is called by `.Last.lib()`. You don't need to care about these under normal circumstances.

Author(s)

Jens Oehlschlägel

See Also

`bit()`

Examples

```
bit_done()
bit_init()
```

---

as.bit.NULL *Coercing to bit*

Description

Coercing to bit vector

Usage

```
## S3 method for class '`NULL`'
as.bit(x, ...)

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

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

## S3 method for class 'integer'
as.bit(x, ...)

## S3 method for class 'double'
as.bit(x, ...)
```

```
## S3 method for class 'bitwhich'
as.bit(x, ...)

## S3 method for class 'which'
as.bit(x, length = attr(x, "maxindex"), ...)

## S3 method for class 'ri'
as.bit(x, ...)

as.bit(x = NULL, ...)
```

Arguments

x	an object of class bit(), logical(), integer(), bitwhich() or an integer from as.which() or a boolean ff
...	further arguments
length	the length of the new bit vector

Details

Coercing to bit is quite fast because we use a double loop that fixes each word in a processor register

Value

is.bit returns FALSE or TRUE, as.bit returns a vector of class 'bit'

Methods (by class)

- as.bit(`NULL`): method to coerce to bit() (zero length) from NULL
- as.bit(bit): method to coerce to bit() from bit()
- as.bit(logical): method to coerce to bit() from logical()
- as.bit(integer): method to coerce to bit() from integer() (0L and NA become FALSE, everthing else becomes TRUE)
- as.bit(double): method to coerce to bit() from double() (0 and NA become FALSE, everthing else becomes TRUE)
- as.bit(bitwhich): method to coerce to bit() from bitwhich()
- as.bit(which): method to coerce to bit() from which()
- as.bit(ri): method to coerce to bit() from ri()

Note

Zero is coerced to FALSE, all other numbers including NA are coerced to TRUE. This differs from the NA-to-FALSE coercion in package ff and may change in the future.

Author(s)

Jens Oehlschlägel

See Also

CoercionToStandard, as.booltype(), as.bit(), as.bitwhich(), as.which(), as.ri(), ff::as.hi(), ff::as.ff()

Examples

```
as.bit(c(0L, 1L, 2L, -2L, NA))
as.bit(c(0, 1, 2, -2, NA))

as.bit(c(FALSE, NA, TRUE))
```

---

as.bitwhich.NULL *Coercing to bitwhich*

Description

Functions to coerce to bitwhich

Usage

```
## S3 method for class '`NULL`'
as.bitwhich(x, ...)

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

## S3 method for class 'which'
as.bitwhich(x, maxindex = attr(x, "maxindex"), ...)

## S3 method for class 'ri'
as.bitwhich(x, ...)

## S3 method for class 'integer'
as.bitwhich(x, poslength = NULL, ...)

## S3 method for class 'double'
as.bitwhich(x, poslength = NULL, ...)

## S3 method for class 'logical'
as.bitwhich(x, poslength = NULL, ...)

## S3 method for class 'bit'
as.bitwhich(x, range = NULL, poslength = NULL, ...)

as.bitwhich(x = NULL, ...)
```

Arguments

x	An object of class 'bitwhich', 'integer', 'logical' or 'bit' or an integer vector as resulting from 'which'
...	further arguments
maxindex	the length of the new bitwhich vector
poslength	the number of selected elements
range	a ri() or an integer vector of length == 2 giving a range restriction for chunked processing

Value

a value of class bitwhich()

Methods (by class)

- as.bitwhich(`NULL`): method to coerce to bitwhich() (zero length) from NULL
- as.bitwhich(bitwhich): method to coerce to bitwhich() from bitwhich()
- as.bitwhich(which): method to coerce to bitwhich() from which()
- as.bitwhich(ri): method to coerce to bitwhich() from ri()
- as.bitwhich(integer): method to coerce to bitwhich() from integer() (0 and NA become FALSE, everthing else becomes TRUE)
- as.bitwhich(double): method to coerce to bitwhich() from double() (0 and NA become FALSE, everthing else becomes TRUE)
- as.bitwhich(logical): method to coerce to bitwhich() from logical()
- as.bitwhich(bit): method to coerce to bitwhich() from bit()

Author(s)

Jens Oehlschlägel

See Also

CoercionToStandard, as.booltype(), as.bit(), as.bitwhich() , as.which(), as.ri(), ff::as.hi(), ff::as.ff()

Examples

```
as.bitwhich(c(0L, 1L, 2L, -2L, NA))
as.bitwhich(c(0, 1, 2, -2, NA))

 as.bitwhich(c(NA, NA, NA))
 as.bitwhich(c(FALSE, FALSE, FALSE))
 as.bitwhich(c(FALSE, FALSE, TRUE))
 as.bitwhich(c(FALSE, TRUE, TRUE))
 as.bitwhich(c(TRUE, TRUE, TRUE))
```

`as.booltype.default` *Coerce to booltype (generic)*

Description

Coerce to booltype (generic)

Usage

```
## Default S3 method:
as.booltype(x, booltype = "logical", ...)

as.booltype(x, booltype, ...)
```

Arguments

`x`	object to coerce
`booltype`	target `booltype()` given as integer or as character
`...`	further arguments

Value

`x` coerced to `booltype`

Methods (by class)

- `as.booltype(default)`: default method for as.booltype

See Also

`CoercionToStandard`, `booltypes()`, `booltype()`, `is.booltype()`

Examples

```
as.booltype(0:1)
as.booltype(0:1, "logical")
as.booltype(0:1, "bit")
as.booltype(0:1, "bitwhich")
as.booltype(0:1, "which", maxindex=2)
as.booltype(0:1, "ri")
```

as.character.bit *Coerce bit to character*

Description

Coerce bit to character

Usage

```
## S3 method for class 'bit'
as.character(x, ...)
```

Arguments

x	a bit() vector
...	ignored

Value

a character vector of zeroes and ones

Examples

```
as.character(bit(12))
```

as.character.bitwhich *Coerce bitwhich to character*

Description

Coerce bitwhich to character

Usage

```
## S3 method for class 'bitwhich'
as.character(x, ...)
```

Arguments

x	a bitwhich() vector
...	ignored

Value

a character vector of zeroes and ones

Examples

```
as.character(bitwhich(12))
```

`as.ri.ri` *Coerce to ri*

Description

Coerce to ri

Usage

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

## Default S3 method:
as.ri(x, ...)

as.ri(x, ...)
```

Arguments

`x`	object to coerce
`...`	further arguments

Value

an `ri()` object

Methods (by class)

- `as.ri(ri)`: method to coerce `ri()` to `ri()`
- `as.ri(default)`: default method to coerce to `ri()`

Author(s)

Jens Oehlschlägel

See Also

`CoercionToStandard`, `as.booltype()`, `as.bit()`, `as.bitwhich()` , `as.which()`, `as.ri()`, `ff::as.hi()`, `ff::as.ff()`

Examples

```
as.ri(c(FALSE, TRUE, FALSE, TRUE))
```

as.which.which *Coercion to (positive) integer positions*

Description

Coercing to something like the result of which `which()`

Usage

```
## S3 method for class 'which'
as.which(x, maxindex = NA_integer_, ...)

## S3 method for class '`NULL`'
as.which(x, ...)

## S3 method for class 'numeric'
as.which(x, maxindex = NA_integer_, ...)

## S3 method for class 'integer'
as.which(x, maxindex = NA_integer_, is.unsorted = TRUE, has.dup = TRUE, ...)

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

## S3 method for class 'ri'
as.which(x, ...)

## S3 method for class 'bit'
as.which(x, range = NULL, ...)

## S3 method for class 'bitwhich'
as.which(x, ...)

as.which(x, ...)
```

Arguments

x	an object of classes `bit()`, `bitwhich()`, `ri()` or something on which `which()` works
maxindex	the length of the boolean vector which is represented
...	further arguments (passed to `which()` for the default method, ignored otherwise)
is.unsorted	a logical scalar indicating whether the data may be unsorted
has.dup	a logical scalar indicating whether the data may have duplicates
range	a `ri()` or an integer vector of length == 2 giving a range restriction for chunked processing

Details

as.which.bit returns a vector of subscripts with class 'which'

Value

a vector of class 'logical' or 'integer'

Methods (by class)

- as.which(which): method to coerce to which() from which()
- as.which(`NULL`): method to coerce to zero length which() from NULL
- as.which(numeric): method to coerce to which() from numeric()
- as.which(integer): method to coerce to which() from integer()
- as.which(logical): method to coerce to which() from logical()
- as.which(ri): method to coerce to which() from ri()
- as.which(bit): method to coerce to which() from bit()
- as.which(bitwhich): method to coerce to which() from bitwhich()

Author(s)

Jens Oehlschlägel

See Also

CoercionToStandard, as.booltype(), as.bit(), as.bitwhich() , as.which(), as.ri(), ff::as.hi(), ff::as.ff()

Examples

```
r <- ri(5, 20, 100)
x <- as.which(r)
x

stopifnot(identical(x, as.which(as.logical(r))))
stopifnot(identical(x, as.which(as.bitwhich(r))))
stopifnot(identical(x, as.which(as.bit(r))))
```

bbatch *Balanced Batch sizes*

Description

bbatch calculates batch sizes in 1..N so that they have rather balanced sizes than very different sizes.

Usage

```
bbatch(N, B)
```

Arguments

N	total size in 0..integer_max
B	desired batch size in 1..integer_max

Details

Tries to have rb == 0 or rb as close to b as possible while guaranteeing that rb < b && (b - rb) <= min(nb, b)

Value

a list with components:

- b: the batch size
- nb: the number of batches
- rb: the size of the rest

Author(s)

Jens Oehlschlägel

See Also

repfromto(), ff::ffvecapply()

Examples

```
bbatch(100, 24)
```

bit *Create empty bit vector*

Description

Bit vectors are a boolean type wihout NA that requires by factor 32 less RAM than logical(). For details on usage see vignette("bit-usage") and for details on performance see vignette("bit-performance").

Usage

```
bit(length = 0L)
```

Arguments

length	length in bits

Value

bit returns a vector of integer sufficiently long to store 'length' bits

See Also

booltype(), bitwhich(), logical()

Examples

```
bit(12)
!bit(12)
str(bit(128))
```

bitsort *Low-level sorting: bit sort*

Description

In one pass over the vector NAs are handled according to parameter na.last by range_sortna(), then, if the vector is unsorted, bit sort is invoked.

Usage

```
bitsort(x, na.last = NA, depth = 1)
```

Arguments

x	an integer vector
na.last	NA removes NAs, FALSE puts NAs at the beginning, TRUE puts NAs at the end
depth	an integer scalar giving the number of bit-passed before switching to quicksort

Value

a sorted vector

Examples

```
bitsort(c(2L, 0L, 1L, NA, 2L))
bitsort(c(2L, 0L, 1L, NA, 2L), na.last=TRUE)
bitsort(c(2L, 0L, 1L, NA, 2L), na.last=FALSE)
```

`bitwhich` *Create bitwhich vector (skewed boolean)*

Description

A bitwhich object represents a boolean filter like a `bit()` object (NAs are not allowed) but uses a sparse representation suitable for very skewed (asymmetric) selections. Three extreme cases are represented with logical values, no length via `logical()`, all `TRUE` with `TRUE` and all `FALSE` with `FALSE`. All other selections are represented with positive or negative integers, whatever is shorter. This needs less RAM compared to `logical()` (and often less than `bit()` or `which()`). Logical operations are fast if the selection is asymmetric (only few or almost all selected).

Usage

```
bitwhich(
  maxindex = 0L,
  x = NULL,
  xempty = FALSE,
  poslength = NULL,
  is.unsorted = TRUE,
  has.dup = TRUE
)
```

Arguments

`maxindex`	length of the vector
`x`	Information about which positions are `FALSE` or `TRUE`: either `logical()` or `TRUE` or `FALSE` or a integer vector of positive or of negative subscripts.
`xempty`	what to assume about parameter `x` if `x=integer(0)`, typically `TRUE` or `FALSE`.
`poslength`	tuning: `poslength` is calculated automatically, you can give `poslength` explicitly, in this case it must be correct and `x` must be sorted and not have duplicates.
`is.unsorted`	tuning: FALSE implies that `x` is already sorted and sorting is skipped
`has.dup`	tuning: FALSE implies that `x` has no duplicates

Value

an object of class 'bitwhich' carrying two attributes

- maxindex: see above
- poslength: see above

See Also

`bitwhich_representation()`, `as.bitwhich()`, `bit()`

Examples

```
bitwhich()
bitwhich(12)
bitwhich(12, x=TRUE)
bitwhich(12, x=3)
bitwhich(12, x=-3)
bitwhich(12, x=integer())
bitwhich(12, x=integer(), xempty=TRUE)
```

`bitwhich_representation`

Diagnose representation of bitwhich

Description

Diagnose representation of bitwhich

Usage

```
bitwhich_representation(x)
```

Arguments

x	a `bitwhich()` object

Value

a scalar, one of `logical()`, `FALSE`, `TRUE`, `-1` or `1`

Examples

```
bitwhich_representation(bitwhich())
bitwhich_representation(bitwhich(12, FALSE))
bitwhich_representation(bitwhich(12, TRUE))
bitwhich_representation(bitwhich(12, -3))
bitwhich_representation(bitwhich(12, 3))
```

bit_in *bit %in%*

Description

fast %in% for integers

Usage

```
bit_in(x, table, retFUN = as.bit)
```

Arguments

x	an integer vector of values to be looked-up
table	an integer vector used as lookup-table
retFUN	a function that coerces bit() and logical() vectors

Details

determines the range of the integers and checks if the density justifies use of a bit vector; if yes, maps x or table – whatever is smaller – into a bit vector and searches the other of table or x in the it vector; if no, falls back to %in%

Value

a boolean vector coerced to retFUN

See Also

%in%

Examples

```
bit_in(1:2, 2:3)
bit_in(1:2, 2:3, retFUN=as.logical)
```

bit_rangediff *bit range difference*

Description

Fast version of `setdiff(rx[1]:rx[2], y)`.

Usage

```
bit_rangediff(rx, y, revx = FALSE, revy = FALSE)
```

Arguments

rx	range of integers given as `ri()` or as a two-element `integer()`
y	an integer vector of elements to exclude
revx	FALSE as is, TRUE to reverse the direction and sign of rx
revy	FALSE as is, TRUE to reverse the direction and sign of y

Details

determines the range of the integers y and checks if the density justifies use of a bit vector; if yes, uses a bit vector for the set operation; if no, falls back to a quicksort and `merge_rangediff()`

Value

an integer vector

See Also

`bit_setdiff()`, `merge_rangediff()`

Examples

```
bit_rangediff(c(1L, 6L), c(3L, 4L))
bit_rangediff(c(6L, 1L), c(3L, 4L))
bit_rangediff(c(6L, 1L), c(3L, 4L), revx=TRUE)
bit_rangediff(c(6L, 1L), c(3L, 4L), revx=TRUE, revy=TRUE)
```

`bit_setops` *bit set operations*

Description

Fast versions of `union()`, `intersect()`, `setdiff()`, symmetric difference and `setequal()` for integers.

Usage

```
bit_union(x, y)

bit_intersect(x, y)

bit_setdiff(x, y)

bit_symdiff(x, y)

bit_setequal(x, y)
```

Arguments

x	an integer vector
y	an integer vector

Details

determines the range of the integers and checks if the density justifies use of a bit vector; if yes, uses a bit vector for finding duplicates; if no, falls back to `union()`, `intersect()`, `setdiff()`, `union(setdiff(x, y), setdiff(y, x))` and `setequal()`

Value

an integer vector

Functions

- `bit_union()`: union
- `bit_intersect()`: intersection
- `bit_setdiff()`: asymmetric difference
- `bit_symdiff()`: symmetricx difference
- `bit_setequal()`: equality

See Also

`bit_in()`, `bit_rangediff()`

Examples

```
bit_union(1:2, 2:3)
bit_intersect(1:2, 2:3)
bit_setdiff(1:2, 2:3)
bit_symdiff(1:2, 2:3)
bit_setequal(1:2, 2:3)
bit_setequal(1:2, 2:1)
```

`bit_sort` *bit sort*

Description

fast sorting of integers

Usage

```
bit_sort(x, decreasing = FALSE, na.last = NA, has.dup = TRUE)
```

Arguments

`x`	an integer vector
`decreasing`	(currently only `FALSE` is supported)
`na.last`	`NA` removes NAs, `FALSE` puts NAs at the beginning, `TRUE` puts NAs at the end
`has.dup`	TRUE (the default) assumes that `x` might have duplicates, set to `FALSE` if duplicates are impossible

Details

determines the range of the integers and checks if the density justifies use of a bit vector; if yes, sorts the first occurences of each integer in the range using a bit vector, sorts the rest and merges; if no, falls back to quicksort.

Value

a sorted vector

See Also

`sort()`, `ramsort()`, `bit_sort_unique()`

Examples

```
bit_sort(c(2L, 1L, NA, NA, 1L, 2L))
bit_sort(c(2L, 1L, NA, NA, 1L, 2L), na.last=FALSE)
bit_sort(c(2L, 1L, NA, NA, 1L, 2L), na.last=TRUE)

## Not run:
x <- sample(1e7, replace=TRUE)
system.time(bit_sort(x))
system.time(sort(x))

## End(Not run)
```

`bit_sort_unique` *bit sort unique*

Description

fast combination of `sort()` and `unique()` for integers

Usage

```
bit_sort_unique(
  x,
  decreasing = FALSE,
  na.last = NA,
  has.dup = TRUE,
  range_na = NULL
)
```

Arguments

`x`	an integer vector
`decreasing`	`FALSE` (ascending) or `TRUE` (descending)
`na.last`	`NA` removes NAs, `FALSE` puts NAs at the beginning, `TRUE` puts NAs at the end
`has.dup`	TRUE (the default) assumes that `x` might have duplicates, set to `FALSE` if duplicates are impossible
`range_na`	`NULL` calls `range_na()`, optionally the result of `range_na()` can be given here to avoid calling it again

Details

determines the range of the integers and checks if the density justifies use of a bit vector; if yes, creates the result using a bit vector; if no, falls back to `sort(unique())`

Value

a sorted unique integer vector

See Also

sort(), unique(), bit_sort(), bit_unique()

Examples

```
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L))
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L), na.last=FALSE)
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L), na.last=TRUE)
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L), decreasing = TRUE)
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L), decreasing = TRUE, na.last=FALSE)
bit_sort_unique(c(2L, 1L, NA, NA, 1L, 2L), decreasing = TRUE, na.last=TRUE)

## Not run:
x <- sample(1e7, replace=TRUE)
system.time(bit_sort_unique(x))
system.time(sort(unique(x)))
x <- sample(1e7)
system.time(bit_sort_unique(x))
system.time(sort(x))

## End(Not run)
```

---

bit_unidup *bit unique and duplicated*

Description

Fast versions of unique(), duplicated() , anyDuplicated() and sum(duplicated(x)) for integers.

Usage

```
bit_unique(x, na.rm = NA, range_na = NULL)

bit_duplicated(x, na.rm = NA, range_na = NULL, retFUN = as.bit)

bit_anyDuplicated(x, na.rm = NA, range_na = NULL)

bit_sumDuplicated(x, na.rm = NA, range_na = NULL)
```

Arguments

x	an integer vector
na.rm	NA treats NAs like other integers, TRUE treats *all* NAs as duplicates, FALSE treats *no* NAs as duplicates
range_na	NULL calls range_na(), optionally the result of range_na() can be given here to avoid calling it again
retFUN	a function that coerces bit() and logical() vectors

Details

determines the range of the integers and checks if the density justifies use of a bit vector; if yes, uses a bit vector for finding duplicates; if no, falls back to `unique()`, `duplicated()`, `anyDuplicated()` and `sum(duplicated(x))`

Value

- `bit_unique` returns a vector of unique integers,
- `bit_duplicated` returns a boolean vector coerced to `retFUN`,
- `bit_anyDuplicated` returns the position of the first duplicate (or zero if no duplicates)
- `bit_sumDuplicated` returns the number of duplicated values (as.integer)

Functions

- `bit_unique()`: extracts unique elements
- `bit_duplicated()`: determines duplicate elements
- `bit_anyDuplicated()`: checks for existence of duplicate elements
- `bit_sumDuplicated()`: counts duplicate elements

See Also

`bit_sort_unique()`

Examples

```
bit_unique(c(2L, 1L, NA, NA, 1L, 2L))
bit_unique(c(2L, 1L, NA, NA, 1L, 2L), na.rm=FALSE)
bit_unique(c(2L, 1L, NA, NA, 1L, 2L), na.rm=TRUE)

bit_duplicated(c(2L, 1L, NA, NA, 1L, 2L))
bit_duplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=FALSE)
bit_duplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=TRUE)

bit_anyDuplicated(c(2L, 1L, NA, NA, 1L, 2L))
bit_anyDuplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=FALSE)
bit_anyDuplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=TRUE)

bit_sumDuplicated(c(2L, 1L, NA, NA, 1L, 2L))
bit_sumDuplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=FALSE)
bit_sumDuplicated(c(2L, 1L, NA, NA, 1L, 2L), na.rm=TRUE)
```

booltype *Diagnosing boolean types*

Description

Specific methods for booltype are required, where non-unary methods can combine multiple boolean types, particularly boolean binary operators.

Usage

```
booltype(x)
```

Arguments

x	an R object

Details

Function booltype returns the boolean type of its argument. There are currently six boolean types, booltypes is an ordered() vector with the following ordinal levels():

- nobool: non-boolean type
- logical(): for representing any boolean data including NA
- bit(): for representing dense boolean data
- bitwhich(): for representing sparse (skewed) boolean data
- which(): for representing sparse boolean data with few 'TRUE
- ri(): range-indexing, for representing sparse boolean data with a single range of TRUE

Value

one scalar element of booltypes() in case of 'nobool' it carries a name attribute with the data type.

Note

do not rely on the internal integer codes of these levels, we might add-in hi later

See Also

booltypes(), is.booltype(), as.booltype()

Examples

```
unname(booltypes)
str(booltypes)
sapply(
  list(double(), integer(), logical(), bit(), bitwhich(), as.which(), ri(1, 2, 3)),
  booltype
)
```

booltypes *Boolean types*

Description

The ordered() factor booltypes ranks the boolean types.

Usage

```
booltypes
```

Format

An object of class ordered (inherits from factor) of length 6.

Details

There are currently six boolean types, booltypes is an ordered() vector with the following ordinal levels():

- nobool: non-boolean type
- logical(): for representing any boolean data including NA
- bit(): for representing dense boolean data
- bitwhich(): for representing sparse (skewed) boolean data
- which(): for representing sparse boolean data with few 'TRUE
- ri(): range-indexing, for representing sparse boolean data with a single range of TRUE

booltypes has a names() attribute such that elements can be selected by name.

Note

do not rely on the internal integer codes of these levels, we might add-in hi later

See Also

booltype(), is.booltype(), as.booltype()

c.booltype *Concatenating booltype vectors*

Description

Creating new boolean vectors by concatenating boolean vectors

Usage

```
## S3 method for class 'booltype'
c(...)

## S3 method for class 'bit'
c(...)

## S3 method for class 'bitwhich'
c(...)
```

Arguments

...	booltype() vectors

Value

a vector with the lowest input booltype() (but not lower thanlogical())

Author(s)

Jens Oehlschlägel

See Also

c(), bit() , bitwhich(), , which()

Examples

```
c(bit(4), !bit(4))
c(bit(4), !bitwhich(4))
c(bitwhich(4), !bit(4))
c(ri(1, 2, 4), !bit(4))
c(bit(4), !logical(4))
message("logical in first argument does not dispatch: c(logical(4), bit(4))")
c.booltype(logical(4), !bit(4))
```

chunk *Methods for chunked range index*

Description

Calls `chunks()` to create a sequence of range indexes along the object which causes the method dispatch.

Usage

```
chunk(x = NULL, ...)

## Default S3 method:
chunk(x = NULL, ..., RECORDBYTES = NULL, BATCHBYTES = NULL)
```

Arguments

x	the object along we want chunks
...	further arguments passed to `chunks()`
RECORDBYTES	integer scalar representing the bytes needed to process a single element of the boolean vector (default 4 bytes for logical)
BATCHBYTES	integer scalar limiting the number of bytes to be processed in one chunk, default from `getOption("ffbatchbytes")` if not null, otherwise 16777216

Details

chunk is generic, the default method is described here, other methods that automatically consider RAM needs are provided with package 'ff', see for example `ff::chunk.ffdf()`

Value

returns a named list of `ri()` objects representing chunks of subscripts

Methods (by class)

- `chunk(default)`: default vector method

available methods

`chunk.default`, `ff::chunk.ff_vector()`, `ff::chunk.ffdf()`

Author(s)

Jens Oehlschlägel

See Also

`chunks()`, `ri()`, `seq()`, `bbatch()`

Examples

```
chunk(complex(1e7))
chunk(raw(1e7))
chunk(raw(1e7), length=3)

chunks(1, 10, 3)
# no longer do
chunk(1, 100, 10)
# but for bckward compatibility this works
chunk(from=1, to=100, by=10)
```

---

chunks *Function for chunked range index*

Description

creates a sequence of range indexes using a syntax not completely unlike 'seq'

Usage

```
chunks(
  from = NULL,
  to = NULL,
  by = NULL,
  length.out = NULL,
  along.with = NULL,
  overlap = 0L,
  method = c("bbatch", "seq"),
  maxindex = NA
)
```

Arguments

from	the starting value of the sequence.
to	the (maximal) end value of the sequence.
by	increment of the sequence
length.out	desired length of the sequence.
along.with	take the length from the length of this argument.
overlap	number of values to overlap (will lower the starting value of the sequence, the first range becomes smaller
method	default 'bbatch' will try to balance the chunk size, see bbatch(), 'seq' will create chunks like seq()
maxindex	passed to ri()

Value

returns a named list of `ri()` objects representing chunks of subscripts

Author(s)

Jens Oehlschlägel

See Also

generic `chunk()`, `ri()`, `seq()`, `bbatch()`

Examples

```
  chunks(1, 100, by=30)
  chunks(1, 100, by=30, method="seq")
   ## Not run:
require(foreach)
m <- 10000
k <- 1000
n <- m*k
message("Four ways to loop from 1 to n. Slowest foreach to fastest chunk is 1700:1
on a dual core notebook with 3GB RAM\n")
z <- 0L;
print(k*system.time({it <- icount(m); foreach (i = it) %do% { z <- i; NULL }}))
z

z <- 0L
print(system.time({i <- 0L; while (i < n) {i <- i + 1L; z <- i}}))
z

z <- 0L
print(system.time(for (i in 1:n) z <- i))
z

z <- 0L; n <- m*k;
print(system.time(for (ch in chunks(1, n, by=m)) {for (i in ch[1]:ch[2]) z <- i}))
z

message("Seven ways to calculate sum(1:n).
 Slowest foreach to fastest chunk is 61000:1 on a dual core notebook with 3GB RAM\n")
print(k*system.time({it <- icount(m); foreach (i = it, .combine="+") %do% { i }}))

z <- 0;
print(k*system.time({it <- icount(m); foreach (i = it) %do% { z <- z + i; NULL }}))
z

z <- 0; print(system.time({i <- 0L;while (i < n) {i <- i + 1L; z <- z + i}})); z

z <- 0; print(system.time(for (i in 1:n) z <- z + i)); z

print(system.time(sum(as.double(1:n))))
```

```
z <- 0; n <- m*k
print(system.time(for (ch in chunks(1, n, by=m)) {for (i in ch[1]:ch[2]) z <- z + i}))
z

z <- 0; n <- m*k
print(system.time(for (ch in chunks(1, n, by=m)) {z <- z + sum(as.double(ch[1]:ch[2]))}))
z

## End(Not run)
```

---

clone *Cloning ff and ram objects*

Description

clone physically duplicates objects and can additionally change some features, e.g. length.

Usage

```
clone(x, ...)

## Default S3 method:
clone(x, ...)
```

Arguments

x	x an R object
...	further arguments to the generic

Details

clone is generic. clone.default handles ram objects. Further methods are provided in package 'ff'. still.identical returns TRUE if the two atomic arguments still point to the same memory.

Value

an object that is a deep copy of x

Methods (by class)

- clone(default): default method uses R's C-API 'duplicate()'

Author(s)

Jens Oehlschlägel

See Also

clone.ff, copy_vector()

Examples

```
x <- 1:12
y <- x
still.identical(x, y)
y[1] <- y[1]
still.identical(x, y)
y <- clone(x)
still.identical(x, y)
rm(x, y); gc()
```

CoercionToStandard *Coercion from bit, bitwhich, which and ri to logical, integer, double*

Description

Coercion from bit is quite fast because we use a double loop that fixes each word in a processor register.

Usage

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

## S3 method for class 'bit'
as.integer(x, ...)

## S3 method for class 'bit'
as.double(x, ...)

## S3 method for class 'bitwhich'
as.integer(x, ...)

## S3 method for class 'bitwhich'
as.double(x, ...)

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

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

## S3 method for class 'ri'
```

```
as.integer(x, ...)

## S3 method for class 'ri'
as.double(x, ...)

## S3 method for class 'which'
as.logical(x, length = attr(x, "maxindex"), ...)
```

Arguments

x	an object of class bit(), bitwhich() or ri()
...	ignored
length	length of the boolean vector (required for as.logical.which)

Value

as.logical() returns a vector of FALSE, TRUE, as.integer() and as.double() return a vector of 0,1.

Author(s)

Jens Oehlschlägel

See Also

CoercionToStandard, as.booltype(), as.bit(), as.bitwhich() , as.which(), as.ri(), ff::as.hi(), ff::as.ff()

Examples

```
x <- ri(2, 5, 10)
y <- as.logical(x)
y
stopifnot(identical(y, as.logical(as.bit(x))))
stopifnot(identical(y, as.logical(as.bitwhich(x))))

y <- as.integer(x)
y
stopifnot(identical(y, as.integer(as.logical(x))))
stopifnot(identical(y, as.integer(as.bit(x))))
stopifnot(identical(y, as.integer(as.bitwhich(x))))

y <- as.double(x)
y
stopifnot(identical(y, as.double(as.logical(x))))
stopifnot(identical(y, as.double(as.bit(x))))
stopifnot(identical(y, as.double(as.bitwhich(x))))
```

copy_vector *Copy atomic R vector*

Description

Creates a true copy of the underlying C-vector – dropping all attributes – and optionally reverses the direction of the elements.

Usage

```
copy_vector(x, revx = FALSE)
```

Arguments

x	an R vector
revx	default FALSE, set to TRUE to reverse the elements in 'x'

Details

This can be substantially faster than `duplicate(as.vector(unclass(x)))`

Value

copied R vector

See Also

clone(), still.identical(), reverse_vector()

Examples

```
x <- factor(letters)
y <- x
z <- copy_vector(x)
still.identical(x, y)
still.identical(x, z)
str(x)
str(y)
str(z)
```

countsort *Low-level sorting: counting sort*

Description

In one pass over the vector NAs are handled according to parameter na.last by range_sortna(), then, if the vector is unsorted, counting sort is invoked.

Usage

```
countsort(x, na.last = NA)
```

Arguments

x	an integer vector
na.last	NA removes NAs, FALSE puts NAs at the beginning, TRUE puts NAs at the end

Value

a sorted vector

Examples

```
countsort(c(2L, 0L, 1L, NA, 2L))
countsort(c(2L, 0L, 1L, NA, 2L), na.last=TRUE)
countsort(c(2L, 0L, 1L, NA, 2L), na.last=FALSE)
```

Extract *Extract or replace part of an boolean vector*

Description

Operators acting on bit() or bitwhich() objects to extract or replace parts.

Usage

```
## S3 method for class 'bit'
x[[i]]

## S3 replacement method for class 'bit'
x[[i]] <- value

## S3 method for class 'bit'
x[i]

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

```
x[i] <- value

## S3 method for class 'bitwhich'
x[[i]]

## S3 replacement method for class 'bitwhich'
x[[i]] <- value

## S3 method for class 'bitwhich'
x[i]

## S3 replacement method for class 'bitwhich'
x[i] <- value
```

Arguments

x	a bit() or bitwhich() object
i	preferrably a positive integer subscript or a ri(), see text
value	new logical or integer values

Details

The typical usecase for '[' and '[<-' is subscripting with positive integers, negative integers are allowed but slower, as logical subscripts only scalars are allowed. The subscript can be given as a bitwhich() object. Also ri() can be used as subscript.

Extracting from bit() and bitwhich() is faster than from logical() if positive subscripts are used. Unteger subscripts make sense. Negative subscripts are converted to positive ones, beware the RAM consumption.

Value

The extractors [[and [return a logical scalar or vector. The replacment functions return an object of class(x).

Author(s)

Jens Oehlschlägel

See Also

bit(), 'Extract"

Examples

```
x <- as.bit(c(FALSE, NA, TRUE))
x[] <- c(FALSE, NA, TRUE)
x[1:2]
x[-3]
x[ri(1, 2)]
```

```
x[as.bitwhich(c(TRUE, TRUE, FALSE))]
x[[1]]
x[] <- TRUE
x[1:2] <- FALSE
x[[1]] <- TRUE
```

`firstNA` *Position of first NA*

Description

This is substantially faster than `which.max(is.na(x))`

Usage

```
firstNA(x)
```

Arguments

x	an R vector

Value

a reversed vector

See Also

`which.max()`, `is.na()`, `anyNA()`, `anyDuplicated()`, `bit_anyDuplicated()`

Examples

```
x <- c(FALSE, NA, TRUE)
firstNA(x)
reverse_vector(x)
## Not run:
x <- 1:1e7
system.time(rev(x))
system.time(reverse_vector(x))

## End(Not run)
```

getsetattr *Attribute setting by reference*

Description

Function `setattr` sets a singe attribute and function `setattributes` sets a list of attributes.

Usage

```
getsetattr(x, which, value)

setattr(x, which, value)

setattributes(x, attributes)
```

Arguments

`x`	an R object
`which`	name of the attribute
`value`	value of the attribute, use NULL to remove this attribute
`attributes`	a named list of attribute values

Details

The attributes of 'x' are changed in place without copying x. function `setattributes` does only change the named attributes, it does not delete the non-names attributes like `attributes()` does.

Value

invisible(), we do not return the changed object to remind you of the fact that this function is called for its side-effect of changing its input object.

Author(s)

Jens Oehlschlägel

References

Writing R extensions – System and foreign language interfaces – Handling R objects in C – Attributes (Version 2.11.1 (2010-06-03) R Development)

See Also

`attr()` `unattr()`

Examples

```
x <- as.single(runif(10))
attr(x, "Csingle")

f <- function(x) attr(x, "Csingle") <- NULL
g <- function(x) setattr(x, "Csingle", NULL)

f(x)
x
g(x)
x

## Not run:

# restart R
library(bit)

mysingle <- function(length = 0) {
  ret <- double(length)
  setattr(ret, "Csingle", TRUE)
  ret
}

# show that mysinge gives exactly the same result as single
identical(single(10), mysingle(10))

# look at the speedup and memory-savings of mysingle compared to single
system.time(mysingle(1e7))
memory.size(max=TRUE)
system.time(single(1e7))
memory.size(max=TRUE)

# look at the memory limits
# on my win32 machine the first line fails
#   because of not enough RAM, the second works
x <- single(1e8)
x <- mysingle(1e8)

# .g. performance with factors
x <- rep(factor(letters), length.out=1e7)
x[1:10]
# look how fast one can do this
system.time(setattr(x, "levels", rev(letters)))
x[1:10]
# look at the performance loss in time caused by the non-needed copying
system.time(levels(x) <- letters)
x[1:10]


# restart R
library(bit)
```

```
simplefactor <- function(n) {
  factor(rep(1:2, length.out=n))
}

mysimplefactor <- function(n) {
  ret <- rep(1:2, length.out=n)
  setattr(ret, "levels", as.character(1:2))
  setattr(ret, "class", "factor")
  ret
}

identical(simplefactor(10), mysimplefactor(10))

system.time(x <- mysimplefactor(1e7))
memory.size(max=TRUE)
system.time(setattr(x, "levels", c("a", "b")))
memory.size(max=TRUE)
x[1:4]
memory.size(max=TRUE)
rm(x)
gc()

system.time(x <- simplefactor(1e7))
memory.size(max=TRUE)
system.time(levels(x) <- c("x", "y"))
memory.size(max=TRUE)
x[1:4]
memory.size(max=TRUE)
rm(x)
gc()


## End(Not run)
```

---

get_length *Get C length of a vector*

Description

Gets C length of a vector ignoring any length-methods dispatched by classes

Usage

```
get_length(x)
```

Arguments

x	a vector

Details

Queries the vector length using C-macro LENGTH, this can be substantially faster than length(unclass(x))

Value

integer scalar

Examples

```
length(bit(12))
get_length(bit(12))
```

---

in.bitwhich *Check existence of integers in table*

Description

If the table is sorted, this can be much faster than %in%

Usage

```
in.bitwhich(x, table, is.unsorted = NULL)
```

Arguments

x	a vector of integer
table	a bitwhich() object or a vector of integer
is.unsorted	logical telling the function whether the table is (un)sorted. With the default NULL FALSE is assumed for bitwhich() tables, otherwise TRUE

Value

logical vector

See Also

%in%

Examples

```
x <- bitwhich(100)
x[3] <- TRUE
in.bitwhich(c(NA, 2, 3), x)
```

intrle *Hybrid Index, C-coded utilities*

Description

These C-coded utilitites speed up index preprocessing considerably.

Usage

```
intrle(x)

intisasc(x, na.method = c("none", "break", "skip")[2])

intisdesc(x, na.method = c("none", "break", "skip")[1])
```

Arguments

x	an integer vector
na.method	one of "none", "break", "skip", see details. The strange defaults stem from the initial usage.

Details

`intrle` is by factor 50 faster and needs less RAM (2x its input vector) compared to `rle()` which needs 9x the RAM of its input vector. This is achieved because we allow the C-code of `intrle` to break when it turns out, that rle-packing will not achieve a compression factor of 3 or better.

`intisasc` is a faster version of `is.unsorted()`: it checks whether `x` is sorted.

`intisdesc` checks for being sorted descending and by default default assumes that the input `x` contains no NAs.

`na.method="none"` treats `NA`s (the smallest integer) like every other integer and hence returns either `TRUE` or `FALSE` `na.method="break"` checks for `NA`s and returns either `NA` as soon as `NA` is encountered. `na.method="skip"` checks for `NA`s and skips over them, hence decides the return value only on the basis of non-NA values.

Value

- `intrle` returns an object of class `rle()` or NULL, if rle-compression is not efficient (compression factor <3 or `length(x)` < 3).
- `intisasc` returns one of `FALSE, NA, TRUE`
- `intisdesc` returns one of `FALSE, TRUE` (if the input contains NAs, the output is undefined)

Functions

- `intisasc()`: check whether integer vector is ascending
- `intisdesc()`: check whether integer vector is descending

Author(s)

Jens Oehlschlägel

See Also

ff::hi(), rle(), is.unsorted(), ff::is.sorted.default()

Examples

```
intrle(sample(1:10))
intrle(diff(1:10))
intisasc(1:10)
intisasc(10:1)
intisasc(c(NA, 1:10))
intisdesc(1:10)
intisdesc(c(10:1, NA))
intisdesc(c(10:6, NA, 5:1))
intisdesc(c(10:6, NA, 5:1), na.method="skip")
intisdesc(c(10:6, NA, 5:1), na.method="break")
```

---

is.booltype *Testing for boolean types*

Description

All booltypes() including logical() except 'nobool' types are considered 'is.booltype'.

Usage

```
is.booltype(x)

is.bit(x)

is.bitwhich(x)

is.which(x)

is.hi(x)

is.ri(x)
```

Arguments

x	an R object

Value

logical scalar

Functions

- is.bit(): tests for bit()
- is.bitwhich(): tests for bitwhich()
- is.which(): tests for which()
- is.hi(): tests for hi
- is.ri(): tests for ri()

See Also

booltypes(), booltype(), as.booltype()

Examples

```
sapply(
  list(double(), integer(), logical(), bit(), bitwhich(), as.which(), ri(1, 2, 3)),
  is.booltype
)
```

---

is.na.bit *Test for NA in bit and bitwhich*

Description

Test for NA in bit and bitwhich

Usage

```
## S3 method for class 'bit'
is.na(x)

## S3 method for class 'bitwhich'
is.na(x)
```

Arguments

x	a bit() or bitwhich() vector

Value

vector of same type with all elements FALSE

Functions

- is.na(bitwhich): method for is.na() from bitwhich()

See Also

is.na()

Examples

```
is.na(bit(6))
is.na(bitwhich(6))
```

---

length.bit *Getting and setting length of bit, bitwhich and ri objects*

Description

Query the number of bits in a bit() vector or change the number of bits in a bit vector. Query the number of bits in a bitwhich()] vector or change the number of bits in a bit vector.

Usage

```
## S3 method for class 'bit'
length(x)

## S3 replacement method for class 'bit'
length(x) <- value

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

## S3 replacement method for class 'bitwhich'
length(x) <- value

## S3 method for class 'ri'
length(x)
```

Arguments

x	a bit(), bitwhich() or ri() object
value	the new number of bits

Details

NOTE that the length does NOT reflect the number of selected (TRUE) bits, it reflects the sum of both, TRUE and FALSE bits. Increasing the length of a bit() object will set new bits to FALSE. The behaviour of increasing the length of a bitwhich() object is different and depends on the content of the object:

- TRUE – all included, new bits are set to TRUE
- positive integers – some included, new bits are set to FALSE

- negative integers – some excluded, new bits are set to TRUE
- FALSE – all excluded:, new bits are set to FALSE

Decreasing the length of bit or bitwhich removes any previous information about the status bits above the new length.

Value

the length A bit vector with the new length

Author(s)

Jens Oehlschlägel

See Also

length(), sum(), poslength(), maxindex()

Examples

```
stopifnot(length(ri(1, 1, 32)) == 32)

x <- as.bit(ri(32, 32, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 0)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 0)

x <- as.bit(ri(1, 1, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 1)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)

x <- as.bitwhich(bit(32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 0)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 0)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 0)
```

```
x <- as.bitwhich(!bit(32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 32)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 16)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 32)

x <- as.bitwhich(ri(32, 32, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 0)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 0)

x <- as.bitwhich(ri(2, 32, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 31)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 15)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 31)

x <- as.bitwhich(ri(1, 1, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 1)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 1)

x <- as.bitwhich(ri(1, 31, 32))
stopifnot(length(x) == 32)
stopifnot(sum(x) == 31)
message("NOTE the change from 'some excluded' to 'all excluded' here")
length(x) <- 16
stopifnot(length(x) == 16)
stopifnot(sum(x) == 16)
length(x) <- 32
stopifnot(length(x) == 32)
stopifnot(sum(x) == 32)
```

maxindex.default *Get maxindex (length of boolean vector) and poslength (number of 'selected' elements)*

Description

For is.booltype() objects the term length() is ambiguous. For example the length of which() corresponds to the sum of logical(). The generic maxindex gives length(logical) for all booltype()s. The generic poslength gives the number of positively selected elements, i.e. sum(logical) for all booltype()s (and gives NA if NAs are present).

Usage

```
## Default S3 method:
maxindex(x, ...)

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

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

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

## S3 method for class 'bit'
maxindex(x, ...)

## S3 method for class 'bit'
poslength(x, ...)

## S3 method for class 'bitwhich'
maxindex(x, ...)

## S3 method for class 'bitwhich'
poslength(x, ...)

## S3 method for class 'which'
maxindex(x, ...)

## S3 method for class 'which'
poslength(x, ...)

## S3 method for class 'ri'
maxindex(x, ...)

## S3 method for class 'ri'
```

```
poslength(x, ...)

maxindex(x, ...)

poslength(x, ...)
```

Arguments

x	an R object, typically a `is.booltype()` object.
...	further arguments (ignored)

Value

an integer scalar

Methods (by class)

- `maxindex(default)`: default method for `maxindex`
- `maxindex(logical)`: `maxindex` method for class `logical()`
- `maxindex(bit)`: `maxindex` method for class `bit()`
- `maxindex(bitwhich)`: `maxindex` method for class `bitwhich()`
- `maxindex(which)`: `maxindex` method for class `which()`
- `maxindex(ri)`: `maxindex` method for class `ri()`

Functions

- `poslength(default)`: default method for `poslength`
- `poslength(logical)`: `poslength` method for class `logical()`
- `poslength(bit)`: `poslength` method for class `bit()`
- `poslength(bitwhich)`: `poslength` method for class `bitwhich()`
- `poslength(which)`: `poslength` method for class `which()`
- `poslength(ri)`: `poslength` method for class `ri()`

Examples

```
r <- ri(1, 2, 12)
i <- as.which(r)
w <- as.bitwhich(r)
b <- as.bit(r)
l <- as.logical(r)
u <- which(l)      # unclassed which

sapply(list(r=r, u=u, i=i, w=w, b=b, l=l), function(x) {
  c(length=length(x), sum=sum(x), maxindex=maxindex(x), poslength=poslength(x))
})
```

merge_rev *Fast functions for sorted sets of integer*

Description

The merge_ functions allow unary and binary operations on (ascending) sorted vectors of integer(). merge_rev(x) will do in one scan what costs two scans in -rev(x), see also reverse_vector(). Many of these merge_ can optionally scan their input in reverse order (and switch the sign), which again saves extra scans for calling merge_rev(x) first.

Usage

```
merge_rev(x)

merge_match(x, y, revx = FALSE, revy = FALSE, nomatch = NA_integer_)

merge_in(x, y, revx = FALSE, revy = FALSE)

merge_notin(x, y, revx = FALSE, revy = FALSE)

merge_duplicated(x, revx = FALSE)

merge_anyDuplicated(x, revx = FALSE)

merge_sumDuplicated(x, revx = FALSE)

merge_unique(x, revx = FALSE)

merge_union(
  x,
  y,
  revx = FALSE,
  revy = FALSE,
  method = c("unique", "exact", "all")
)

merge_setdiff(x, y, revx = FALSE, revy = FALSE, method = c("unique", "exact"))

merge_symdiff(x, y, revx = FALSE, revy = FALSE, method = c("unique", "exact"))

merge_intersect(
  x,
  y,
  revx = FALSE,
  revy = FALSE,
  method = c("unique", "exact")
)
```

```
merge_setequal(x, y, revx = FALSE, revy = FALSE, method = c("unique", "exact"))

merge_rangein(rx, y, revx = FALSE, revy = FALSE)

merge_rangenotin(rx, y, revx = FALSE, revy = FALSE)

merge_rangesect(rx, y, revx = FALSE, revy = FALSE)

merge_rangediff(rx, y, revx = FALSE, revy = FALSE)

merge_first(x, revx = FALSE)

merge_last(x, revx = FALSE)

merge_firstin(rx, y, revx = FALSE, revy = FALSE)

merge_lastin(rx, y, revx = FALSE, revy = FALSE)

merge_firstnotin(rx, y, revx = FALSE, revy = FALSE)

merge_lastnotin(rx, y, revx = FALSE, revy = FALSE)
```

Arguments

x	a sorted set
y	a sorted set
revx	default FALSE, set to TRUE to reverse scan parameter 'x'
revy	default FALSE, set to TRUE to reverse scan parameter 'y'
nomatch	integer value returned for non-matched elements, see match()
method	one of "unique", "exact" (or "all") which governs how to treat ties, see the function descriptions
rx	range of integers given as ri() or as a two-element integer()

Details

These are low-level functions and hence do not check whether the set is actually sorted. Note that the merge_* and merge_range* functions have no special treatment for NA. If vectors with NA are sorted ith NA in the first positions (na.last=FALSE) and arguments revx= or revy= have not been used, then NAs are treated like ordinary integers. NA sorted elsewhere or using revx= or revy= can cause unexpected results (note for example that revx= switches the sign on all integers but NAs).

The *binary* merge_* functions have a method="exact" which in both sets treats consecutive occurrences of the same value as if they were different values, more precisely they are handled as if the identity of ties were tuples of ties, rank(ties). method="exact" delivers unique output if the input is unique, and in this case works faster than method="unique".

Value

merge_rev(x) returns -rev(x) for integer() and double() and !rev(x) for logical()

Functions

- merge_match(): returns integer positions of sorted set x in sorted set y, see match(x, y, ...)
- merge_in(): returns logical existence of sorted set x in sorted set y, see x %in% y
- merge_notin(): returns logical in-existence of sorted set x in sorted set y, see !(x %in% y)
- merge_duplicated(): returns the duplicated status of a sorted set x, see duplicated()
- merge_anyDuplicated(): returns the anyDuplicated status of a sorted set x, see anyDuplicated()
- merge_sumDuplicated(): returns the sumDuplicated status of a sorted set x, see bit_sumDuplicated()
- merge_unique(): returns unique elements of sorted set x, see unique()
- merge_union(): returns union of two sorted sets. Default method='unique' returns a unique sorted set, see union(); method='exact' returns a sorted set with the maximum number of ties in either input set; method='all' returns a sorted set with the sum of ties in both input sets.
- merge_setdiff(): returns sorted set x minus sorted set y Default method='unique' returns a unique sorted set, see setdiff(); ethod='exact' returns a sorted set with sum(x ties) minus sum(y ties);
- merge_symdiff(): returns those elements that are in sorted set y xor() in sorted set y Default method='unique' returns the sorted unique set complement, see symdiff(); method='exact' returns a sorted set set complement with abs(sum(x ties) - sum(y ties)).
- merge_intersect(): returns the intersection of two sorted sets x and y Default method='unique' returns the sorted unique intersect, see intersect(); method='exact' returns the intersect with the minium number of ties in either set;
- merge_setequal(): returns TRUE for equal sorted sets and FALSE otherwise Default method='unique' compares the sets after removing ties, see setequal(); method='exact' compares the sets without removing ties;
- merge_rangein(): returns logical existence of range rx in sorted set y, see merge_in()
- merge_rangenotin(): returns logical in-existence of range rx in sorted set y, see merge_notin()
- merge_rangesect(): returns the intersection of range rx and sorted set y, see merge_intersect()
- merge_rangediff(): returns range rx minus sorted set y, see merge_setdiff()
- merge_first(): quickly returns the first element of a sorted set x (or NA if x is empty), hence x[1] or merge_rev(x)[1]
- merge_last(): quickly returns the last element of a sorted set x, (or NA if x is empty), hence x[n] or merge_rev(x)[n]
- merge_firstin(): quickly returns the first common element of a range rx and a sorted set y, (or NA if the intersection is empty), hence merge_first(merge_rangesect(rx, y))
- merge_lastin(): quickly returns the last common element of a range rx and a sorted set y, (or NA if the intersection is empty), hence merge_last(merge_rangesect(rx, y))
- merge_firstnotin(): quickly returns the first element of a range rx which is not in a sorted set y (or NA if all rx are in y), hence merge_first(merge_rangediff(rx, y))
- merge_lastnotin(): quickly returns the last element of a range rx which is not in a sorted set y (or NA if all rx are in y), hence merge_last(merge_rangediff(rx, y))

Note

xx OPTIMIZATION OPPORTUNITY These are low-level functions could be optimized with initial binary search (not findInterval, which coerces to double).

Examples

```
merge_rev(1:9)

merge_match(1:7, 3:9)
#' merge_match(merge_rev(1:7), 3:9)
merge_match(merge_rev(1:7), 3:9, revx=TRUE)
merge_match(merge_rev(1:7), 3:9, revy=TRUE)
merge_match(merge_rev(1:7), merge_rev(3:9))

merge_in(1:7, 3:9)
merge_notin(1:7, 3:9)

merge_anyDuplicated(c(1L, 1L, 2L, 3L))
merge_duplicated(c(1L, 1L, 2L, 3L))
merge_unique(c(1L, 1L, 2L, 3L))

merge_union(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L))
merge_union(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L), method="exact")
merge_union(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L), method="all")

merge_setdiff(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L))
merge_setdiff(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L), method="exact")
merge_setdiff(c(1L, 2L, 2L), c(2L, 2L, 2L, 3L), method="exact")

merge_symdiff(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L))
merge_symdiff(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L), method="exact")
merge_symdiff(c(1L, 2L, 2L), c(2L, 2L, 2L, 3L), method="exact")

merge_intersect(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L))
merge_intersect(c(1L, 2L, 2L, 2L), c(2L, 2L, 3L), method="exact")

merge_setequal(c(1L, 2L, 2L), c(1L, 2L))
merge_setequal(c(1L, 2L, 2L), c(1L, 2L, 2L))
merge_setequal(c(1L, 2L, 2L), c(1L, 2L), method="exact")
merge_setequal(c(1L, 2L, 2L), c(1L, 2L, 2L), method="exact")
```

Metadata *Generics related to cache access*

Description

These generics are packaged here for methods in packages `bit64` and `ff`.

Usage

```
is.sorted(x, ...)

is.sorted(x, ...) <- value

na.count(x, ...)

na.count(x, ...) <- value

nvalid(x, ...)

nunique(x, ...)

nunique(x, ...) <- value

nties(x, ...)

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

Arguments

x	some object
...	ignored
value	value assigned on responsibility of the user

Details

see help of the available methods

Value

see help of the available methods

Author(s)

Jens Oehlschlägel Jens.Oehlschlaegel@truecluster.com

See Also

bit64::is.sorted.integer64(), bit64::na.count.integer64(), bit64::nvalid.integer64(), bit64::nunique.integer64(), bit64::nties.integer64()

Examples

```
methods("na.count")
```

`physical.default` *Physical and virtual attributes*

Description

Compatibility functions (to package ff) for getting and setting physical and virtual attributes.

Usage

```
## Default S3 method:
physical(x)

## Default S3 replacement method:
physical(x) <- value

## Default S3 method:
virtual(x)

## Default S3 replacement method:
virtual(x) <- value

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

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

physical(x)

physical(x) <- value

virtual(x)

virtual(x) <- value
```

Arguments

`x`	a ff or ram object
`value`	a list with named elements
`...`	further arguments

Details

ff objects have physical and virtual attributes, which have different copying semantics: physical attributes are shared between copies of ff objects while virtual attributes might differ between copies. `ff::as.ram()` will retain some physical and virtual atrributes in the ram clone, such that `ff::as.ff()` can restore an ff object with the same attributes.

Value

physical and virtual returns a list with named elements

Author(s)

Jens Oehlschlägel

See Also

ff::physical.ff(), ff::physical.ffdf()

Examples

```
physical(bit(12))
virtual(bit(12))
```

---

print.bit *Print method for bit*

Description

Print method for bit

Usage

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

Arguments

x	a bit vector
...	passed to print

Value

a character vector showing first and last elements of the bit vector

Examples

```
print(bit(120))
```

print.bitwhich *Print method for bitwhich*

Description

Print method for bitwhich

Usage

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

Arguments

x	a bitwhich() object
...	ignored

quicksort2 *Low-level sorting: binary quicksort*

Description

In one pass over the vector NAs are handled according to parameter na.last by range_sortna(), then, if the vector is unsorted, binary quicksort is invoked.

Usage

```
quicksort2(x, na.last = NA)
```

Arguments

x	an integer vector
na.last	NA removes NAs, FALSE puts NAs at the beginning, TRUE puts NAs at the end

Value

a sorted vector

Examples

```
quicksort2(c(2L, 0L, 1L, NA, 2L))
quicksort2(c(2L, 0L, 1L, NA, 2L), na.last=TRUE)
quicksort2(c(2L, 0L, 1L, NA, 2L), na.last=FALSE)
```

quicksort3 *Low-level sorting: threeway quicksort*

Description

In one pass over the vector NAs are handled according to parameter `na.last` by `range_sortna()`, then, if the vector is unsorted, threeway quicksort is invoked.

Usage

```
quicksort3(x, na.last = NA)
```

Arguments

`x`	an integer vector
`na.last`	NA removes NAs, FALSE puts NAs at the beginning, TRUE puts NAs at the end

Value

a sorted vector

Examples

```
countsort(c(2L, 0L, 1L, NA, 2L))
countsort(c(2L, 0L, 1L, NA, 2L), na.last=TRUE)
countsort(c(2L, 0L, 1L, NA, 2L), na.last=FALSE)
```

range_na *Get range and number of NAs*

Description

Get range and number of NAs

Usage

```
range_na(x)
```

Arguments

`x`	an integer vector

Value

an integer vector with three elements:

1. min integer
2. max integer
3. number of NAs

See Also

`range_nanozero()` and `range_sortna()`

Examples

```
range_na(c(0L, 1L, 2L, NA))
```

`range_nanozero` *Remove zeros and get range and number of NAs*

Description

Remove zeros and get range and number of NAs

Usage

```
range_nanozero(x)
```

Arguments

x	an integer vector

Value

an integer vector without zeros and with an attribute `range_na()` with three elements:

1. min integer
2. max integer
3. number of NAs

See Also

`range_na()` and `range_sortna()`

Examples

```
range_nanozero(c(0L, 1L, 2L, NA))
```

range_sortna *Prepare for sorting and get range, number of NAs and unsortedness*

Description

In one pass over the vector NAs are treated according to parameter na.last exactly like sort() does, the range(), number of NAs and unsortedness is determined.

Usage

```
range_sortna(x, decreasing = FALSE, na.last = NA)
```

Arguments

x	an integer vector
decreasing	(currently only FALSE is supported)
na.last	NA removes NAs, FALSE puts NAs at the beginning, TRUE puts NAs at the end

Value

an integer vector with NAs are treated and an attribute range_na() with four elements:

1. min integer
2. max integer
3. number of NAs
4. 0 for sorted vector and 1 for is.unsorted()

See Also

range_na() and range_nanozero()

Examples

```
range_sortna(c(0L, 1L, NA, 2L))
range_sortna(c(2L, NA, 1L, 0L))
range_sortna(c(0L, 1L, NA, 2L), na.last=TRUE)
range_sortna(c(2L, NA, 1L, 0L), na.last=TRUE)
range_sortna(c(0L, 1L, NA, 2L), na.last=FALSE)
range_sortna(c(2L, NA, 1L, 0L), na.last=FALSE)
```

rep.booltype *Replicating bit and bitwhich vectors*

Description

Creating new bit or bitwhich by recycling such vectors

Usage

```
## S3 method for class 'bit'
rep(x, times = 1L, length.out = NA, ...)

## S3 method for class 'bitwhich'
rep(x, times = 1L, length.out = NA, ...)
```

Arguments

x	bit or bitwhich object
times	number of replications
length.out	final length of replicated vector (dominates times)
...	not used

Value

An object of class 'bit' or 'bitwhich'

Author(s)

Jens Oehlschlägel

See Also

rep(), bit() , bitwhich()

Examples

```
rep(as.bit(c(FALSE, TRUE)), 2)
rep(as.bit(c(FALSE, TRUE)), length.out=7)
rep(as.bitwhich(c(FALSE, TRUE)), 2)
rep(as.bitwhich(c(FALSE, TRUE)), length.out=1)
```

repeat.time *Adaptive timer*

Description

Repeats timing expr until minSec is reached

Usage

```
repeat.time(expr, gcFirst = TRUE, minSec = 0.5, envir = parent.frame())
```

Arguments

expr	Valid expression to be timed.
gcFirst	Logical - should a garbage collection be performed immediately before the timing? Default is TRUE.
minSec	number of seconds to repeat at least
envir	the environment in which to evaluate expr (by default the calling frame)

Value

A object of class "proc_time": see proc.time() for details.

Author(s)

Jens Oehlschlägel Jens.Oehlschlaegel@truecluster.com

See Also

system.time()

Examples

```
system.time(1 + 1)
repeat.time(1 + 1)
system.time(sort(runif(1e6)))
repeat.time(sort(runif(1e6)))
```

repfromto *Virtual recycling*

Description

repfromto virtually recylcles object x and cuts out positions from .. to

Usage

```
repfromto(x, from, to)

repfromto(x, from, to) <- value
```

Arguments

x	an object from which to recycle
from	first position to return
to	last position to return
value	value to assign

Details

repfromto is a generalization of rep(), where rep(x, n) == repfromto(x, 1, n). You can see this as an R-side (vector) solution of the mod_iterate macro in arithmetic.c

Value

a vector of length from - to + 1

Author(s)

Jens Oehlschlägel

See Also

rep(), ff::ffvecapply()

Examples

```
message("a simple example")
repfromto(0:9, 11, 20)
```

rev.booltype *Reversing bit and bitwhich vectors*

Description

Creating new bit or bitwhich by reversing such vectors

Usage

```
## S3 method for class 'bit'
rev(x)

## S3 method for class 'bitwhich'
rev(x)
```

Arguments

x	bit or bitwhich object

Value

An object of class 'bit' or 'bitwhich'

Author(s)

Jens Oehlschlägel

See Also

rev(), bit() , bitwhich()

Examples

```
rev(as.bit(c(FALSE, TRUE)))
rev(as.bitwhich(c(FALSE, TRUE)))
```

reverse_vector *Reverse atomic vector*

Description

Returns a reversed copy – with attributes retained.

Usage

```
reverse_vector(x)
```

Arguments

x	an R vector

Details

This is substantially faster than `rev()`

Value

a reversed vector

See Also

`rev()`, `copy_vector()`

Examples

```
x <- factor(letters)
rev(x)
reverse_vector(x)
## Not run:
x <- 1:1e7
system.time(rev(x))
system.time(reverse_vector(x))

## End(Not run)
```

---

ri *Range index*

Description

A range index can be used to extract or replace a continuous ascending part of the data

Usage

```
ri(from, to = NULL, maxindex = NA)

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

Arguments

from	first position
to	last posistion
maxindex	the maximal length of the object-to-be-subscripted (if known)
x	an object of class 'ri'
...	further arguments

Value

A two element integer vector with class 'ri'

Author(s)

Jens Oehlschlägel

See Also

ff::as.hi()

Examples

```
bit(12)[ri(1, 6)]
```

---

rlepack *Hybrid Index, rle-pack utilities*

Description

Basic utilities for rle packing and unpacking and apropriate methods for rev() and unique().

Usage

```
rlepack(x, ...)

## S3 method for class 'integer'
rlepack(x, pack = TRUE, ...)

rleunpack(x)

## S3 method for class 'rlepack'
rleunpack(x)

## S3 method for class 'rlepack'
rev(x)

## S3 method for class 'rlepack'
unique(x, incomparables = FALSE, ...)

## S3 method for class 'rlepack'
anyDuplicated(x, incomparables = FALSE, ...)
```

Arguments

x	in 'rlepack' an integer vector, in the other functions an object of class 'rlepack'
...	just to keep R CMD CHECK quiet (not used)
pack	FALSE to suppress packing
incomparables	just to keep R CMD CHECK quiet (not used)

Value

A list with components:

- first: the first element of the packed sequence
- dat: either an object of class `rle()` or the complete input vector x if rle-packing is not efficient
- last: the last element of the packed sequence

Author(s)

Jens Oehlschlägel

See Also

`ff::hi()`, `intrle()`, `rle()`, `rev()`, `unique()`

Examples

```
x <- rlepack(rep(0L, 10))
```

Sorting *Generics for in-RAM sorting and ordering*

Description

These are generic stubs for low-level sorting and ordering methods implemented in packages 'bit64' and 'ff'. The `..sortorder` methods do sorting and ordering at once, which requires more RAM than ordering but is (almost) as fast as as sorting.

Usage

```
ramsort(x, ...)

ramorder(x, i, ...)

ramsortorder(x, i, ...)

mergesort(x, ...)
```

```
mergeorder(x, i, ...)

mergesortorder(x, i, ...)

quicksort(x, ...)

quickorder(x, i, ...)

quicksortorder(x, i, ...)

shellsort(x, ...)

shellorder(x, i, ...)

shellsortorder(x, i, ...)

radixsort(x, ...)

radixorder(x, i, ...)

radixsortorder(x, i, ...)

keysort(x, ...)

keyorder(x, i, ...)

keysortorder(x, i, ...)
```

Arguments

x	a vector to be sorted by `ramsort()` and `ramsortorder()`, i.e. the output of `sort()`
...	further arguments to the sorting methods
i	integer positions to be modified by `ramorder()` and `ramsortorder()`, default is 1:n, in this case the output is similar to `order()`

Details

The `sort` generics do sort their argument 'x', some methods need temporary RAM of the same size as 'x'. The `order` generics do order their argument 'i' leaving 'x' as it was, some methods need temporary RAM of the same size as 'i'. The `sortorder` generics do sort their argument 'x' and order their argument 'i', this way of ordering is much faster at the price of requiring temporary RAM for both, 'x' and 'i', if the method requires temporary RAM. The `ram` generics are high-level functions containing an optimizer that chooses the 'best' algorithms given some context.

Value

These functions return the number of `NAs` found or assumed during sorting

Index of implemented methods

generic	ff	bit64
ramsort	ff::ramsort.default()	bit64::ramsort.integer64()
shellsort	ff::shellsort.default()	bit64::shellsort.integer64()
quicksort		bit64::quicksort.integer64()
mergesort	ff::mergesort.default()	bit64::mergesort.integer64()
radixsort	ff::radixsort.default()	bit64::radixsort.integer64()
keysort	ff::keysort.default()	
ramorder	ff::ramorder.default()	bit64::ramorder.integer64()
shellorder	ff::shellorder.default()	bit64::shellorder.integer64()
quickorder		bit64::quickorder.integer64()
mergeorder	ff::mergeorder.default()	bit64::mergeorder.integer64()
radixorder	ff::radixorder.default()	bit64::radixorder.integer64()
keyorder	ff::keyorder.default()	
ramsortorder		bit64::ramsortorder.integer64()
shellsortorder		bit64::shellsortorder.integer64()
quicksortorder		bit64::quicksortorder.integer64()
mergesortorder		bit64::mergesortorder.integer64()
radixsortorder		bit64::radixsortorder.integer64()
keysortorder		

Note

Note that these methods purposely violate the functional programming paradigm: they are called for the side-effect of changing some of their arguments. The rationale behind this is that sorting is very RAM-intensive and in certain situations we might not want to allocate additional memory if not necessary to do so. The `sort`-methods change `x`, the `order`-methods change `i`, and the `sortoder`-methods change both `x` and `i` You as the user are responsible to create copies of the input data 'x' and 'i' if you need non-modified versions.

Author(s)

Jens Oehlschlägel Jens.Oehlschlaegel@truecluster.com

See Also

`sort()` and `order()` in base R, `bitsort()` for faster inteer sorting

still.identical *Test for C-level identity of two atomic vectors*

Description

Test for C-level identity of two atomic vectors

Usage

```
still.identical(x, y)
```

Arguments

x	an atomic vector
y	an atomic vector

Value

logical scalar

Examples

```
x <- 1:2
y <- x
z <- copy_vector(x)
still.identical(y, x)
still.identical(z, x)
```

str.bit *Str method for bit*

Description

To actually view the internal structure use `str(unclass(bit))`

Usage

```
## S3 method for class 'bit'
str(
  object,
  vec.len = str0$vec.len,
  give.head = TRUE,
  give.length = give.head,
  ...
)
```

Arguments

object	any R object about which you want to have some information.
vec.len	numeric (>= 0) indicating how many 'first few' elements are displayed of each vector. The number is multiplied by different factors (from .5 to 3) depending on the kind of vector. Defaults to the vec.len component of option "str" (see options) which defaults to 4.
give.head	logical; if TRUE (default), give (possibly abbreviated) mode/class and length (as *type*[1:...]).
give.length	logical; if TRUE (default), indicate length (as [1:...]).
...	potential further arguments (required for Method/Generic reasons).

Value

invisible()

Examples

```
str(bit(120))
```

---

str.bitwhich *Str method for bitwhich*

Description

To actually view the internal structure use str(unclass(bitwhich))

Usage

```
## S3 method for class 'bitwhich'
str(
  object,
  vec.len = str0$vec.len,
  give.head = TRUE,
  give.length = give.head,
  ...
)
```

Arguments

object	any R object about which you want to have some information.
vec.len	numeric (>= 0) indicating how many 'first few' elements are displayed of each vector. The number is multiplied by different factors (from .5 to 3) depending on the kind of vector. Defaults to the vec.len component of option "str" (see options) which defaults to 4.
give.head	logical; if TRUE (default), give (possibly abbreviated) mode/class and length (as *type*[1:...]).

give.length	logical; if TRUE (default), indicate length (as [1:...]).
...	potential further arguments (required for Method/Generic reasons).

Value

invisible()

Examples

```
str(bitwhich(120))
```

Summaries *Summaries of boolean vectors*

Description

Fast aggregation functions for booltype() vectors. namely bit(), all(), any(), anyNA(), min(), max(), range(), sum() and summary(). Now all boolean summaries (except for anyNA because the generic does not allow it) have an optional range argument to restrict the range of evalution. Note that the boolean summaries have meaning and return values differing from logical aggregation functions: they treat NA as FALSE, min, max and range give the minimum and maximum positions of TRUE, summary returns counts of FALSE, TRUE and the range. Note that you can force the boolean interpretation by calling the booltype method explicitly on any booltypes input, e.g. min.booltype(), see the examples.

Usage

```
## S3 method for class 'bit'
all(x, range = NULL, ...)

## S3 method for class 'bit'
any(x, range = NULL, ...)

## S3 method for class 'bit'
anyNA(x, recursive = FALSE)

## S3 method for class 'bit'
sum(x, range = NULL, ...)

## S3 method for class 'bit'
min(x, range = NULL, ...)

## S3 method for class 'bit'
max(x, range = NULL, ...)

## S3 method for class 'bit'
range(x, range = NULL, ...)
```

```
## S3 method for class 'bit'
summary(object, range = NULL, ...)

## S3 method for class 'bitwhich'
all(x, range = NULL, ...)

## S3 method for class 'bitwhich'
any(x, range = NULL, ...)

## S3 method for class 'bitwhich'
anyNA(x, recursive = FALSE)

## S3 method for class 'bitwhich'
sum(x, range = NULL, ...)

## S3 method for class 'bitwhich'
min(x, range = NULL, ...)

## S3 method for class 'bitwhich'
max(x, range = NULL, ...)

## S3 method for class 'bitwhich'
range(x, range = NULL, ...)

## S3 method for class 'bitwhich'
summary(object, range = NULL, ...)

## S3 method for class 'which'
all(x, range = NULL, ...)

## S3 method for class 'which'
any(x, range = NULL, ...)

## S3 method for class 'which'
anyNA(x, recursive = FALSE)

## S3 method for class 'which'
sum(x, range = NULL, ...)

## S3 method for class 'which'
min(x, range = NULL, ...)

## S3 method for class 'which'
max(x, range = NULL, ...)

## S3 method for class 'which'
range(x, range = NULL, ...)
```

```
## S3 method for class 'which'
summary(object, range = NULL, ...)

## S3 method for class 'booltype'
all(x, range = NULL, ...)

## S3 method for class 'booltype'
any(x, range = NULL, ...)

## S3 method for class 'booltype'
anyNA(x, ...)

## S3 method for class 'booltype'
sum(x, range = NULL, ...)

## S3 method for class 'booltype'
min(x, range = NULL, ...)

## S3 method for class 'booltype'
max(x, range = NULL, ...)

## S3 method for class 'booltype'
range(x, range = NULL, ...)

## S3 method for class 'booltype'
summary(object, range = NULL, ...)

## S3 method for class 'ri'
all(x, range = NULL, ...)

## S3 method for class 'ri'
any(x, range = NULL, ...)

## S3 method for class 'ri'
anyNA(x, recursive = FALSE)

## S3 method for class 'ri'
sum(x, ...)

## S3 method for class 'ri'
min(x, ...)

## S3 method for class 'ri'
max(x, ...)

## S3 method for class 'ri'
range(x, ...)
```

```
## S3 method for class 'ri'
summary(object, ...)
```

Arguments

x	an object of class bit or bitwhich
range	a ri() or an integer vector of length == 2 giving a range restriction for chunked processing
...	formally required but not used
recursive	formally required but not used
object	an object of class bit

Details

Summaries of bit() vectors are quite fast because we use a double loop that fixes each word in a processor register. Furthermore we break out of looping as soon as possible. Summaries of bitwhich() vectors are even faster, if the selection is very skewed.

Value

as expected

Author(s)

Jens Oehlschlägel

See Also

length()

Examples

```
l <- c(NA, FALSE, TRUE)
b <- as.bit(l)

all(l)
all(b)
all(b, range=c(3, 3))
all.booltype(l, range=c(3, 3))

min(l)
min(b)

sum(l)
sum(b)

summary(l)
summary(b)
summary.booltype(l)
```

symdiff *Symmetric set complement*

Description

Symmetric set complement

Usage

```
symdiff(x, y)
```

Arguments

x	a vector
y	a vector

Value

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

Note

that `symdiff(x, y)` is not `identical()` as `symdiff(y, x)` without applying `sort()` to the result

See Also

`merge_symdiff()` and `xor()`

Examples

```
symdiff(c(1L, 2L, 2L), c(2L, 3L))
symdiff(c(2L, 3L), c(1L, 2L, 2L))
```

unattr *Attribute removal*

Description

Returns object with attributes removed

Usage

```
unattr(x)
```

Arguments

x	any R object

Details

attribute removal copies the object as usual

Value

a similar object with attributes removed

Author(s)

Jens Oehlschlägel

See Also

`attributes()`, `setattributes()`, `unclass()`

Examples

```
bit(2)[]
unattr(bit(2)[])
```

---

vecseq *Vectorized Sequences*

Description

`vecseq` returns concatenated multiple sequences

Usage

```
vecseq(x, y = NULL, concat = TRUE, eval = TRUE)
```

Arguments

`x`	vector of sequence start points
`y`	vector of sequence end points (if `is.null(y)` then `x` are taken as endpoints, all starting at 1)
`concat`	vector of sequence end points (if `is.null(y)` then `x` are taken as endpoints, all starting at 1)
`eval`	vector of sequence end points (if `is.null(y)` then `x` are taken as endpoints, all starting at 1)

Details

This is a generalization of `sequence()` in that you can choose sequence starts other than 1 and also have options to no concat and/or return a call instead of the evaluated sequence.

Value

- if concat == FALSE and eval == FALSE a list with n calls that generate sequences
- if concat == FALSE and eval == TRUE a list with n sequences
- if concat == TRUE and eval == FALSE a single call generating the concatenated sequences
- if concat == TRUE and eval == TRUE an integer vector of concatentated sequences

Author(s)

Angelo Canty, Jens Oehlschlägel

See Also

:, seq(), sequence()

Examples

```
sequence(c(3, 4))
vecseq(c(3, 4))
vecseq(c(1, 11), c(5, 15))
vecseq(c(1, 11), c(5, 15), concat=FALSE, eval=FALSE)
vecseq(c(1, 11), c(5, 15), concat=FALSE, eval=TRUE)
vecseq(c(1, 11), c(5, 15), concat=TRUE, eval=FALSE)
vecseq(c(1, 11), c(5, 15), concat=TRUE, eval=TRUE)
```

---

xor.default *Boolean operators and functions*

Description

Boolean NEGATION '!', AND '&', OR '|' and EXCLUSIVE OR xor', see Logic.

Usage

```
## Default S3 method:
xor(x, y)

## S3 method for class 'logical'
xor(x, y)

## S3 method for class 'bit'
!x

## S3 method for class 'bit'
e1 & e2

## S3 method for class 'bit'
```

```
e1 | e2

## S3 method for class 'bit'
e1 == e2

## S3 method for class 'bit'
e1 != e2

## S3 method for class 'bit'
xor(x, y)

## S3 method for class 'bitwhich'
!x

## S3 method for class 'bitwhich'
e1 & e2

## S3 method for class 'bitwhich'
e1 | e2

## S3 method for class 'bitwhich'
e1 == e2

## S3 method for class 'bitwhich'
e1 != e2

## S3 method for class 'bitwhich'
xor(x, y)

## S3 method for class 'booltype'
e1 & e2

## S3 method for class 'booltype'
e1 | e2

## S3 method for class 'booltype'
e1 == e2

## S3 method for class 'booltype'
e1 != e2

## S3 method for class 'booltype'
xor(x, y)

xor(x, y)
```

Arguments

x	a is.booltype() vector

y	a is.booltype() vector
e1	a is.booltype() vector
e2	a is.booltype() vector

Details

The binary operators and function xor can now combine any is.booltype() vectors. They now recycle if vectors have different length. If the two arguments have different booltypes() the return value corresponds to the lower booltype() of the two.

Boolean operations on bit() vectors are extremely fast because they are implemented using C's bitwise operators. Boolean operations on or bitwhich() vectors are even faster, if they represent very skewed selections.

The xor function has been made generic and xor.default has been implemented much faster than R's standard xor(). This was possible because actually boolean function xor and comparison operator != do the same (even with NAs), and != is much faster than the multiple calls in (x | y) & !(x & y)

Value

An object of class booltype() or logical()

Methods (by class)

- xor(default): default method for xor()
- xor(logical): logical() method for xor()
- xor(bit): bit() method for xor()
- xor(bitwhich): bitwhich() method for xor()
- xor(booltype): booltype() method for xor()

Functions

- `!`(bit): bit() method for !
- & : bit() method for &
- | : bit() method for |
- == : bit() method for ==
- != : bit() method for !=
- `!`(bitwhich): bitwhich() method for !
- & : bitwhich() method for &
- | : bitwhich() method for |
- == : bitwhich() method for ==
- != : bitwhich() method for !=
- & : booltype() method for &
- | : booltype() method for |
- == : booltype() method for ==
- != : booltype() method for !=

Author(s)

Jens Oehlschlägel

See Also

booltypes(), Logic

Examples

```
x <- c(FALSE, FALSE, FALSE, NA, NA, NA, TRUE, TRUE, TRUE)
y <- c(FALSE, NA, TRUE, FALSE, NA, TRUE, FALSE, NA, TRUE)

x | y
x | as.bit(y)
x | as.bitwhich(y)
x | as.which(y)
x | ri(1, 1, 9)
```

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