

# Package ‘broadcast’

March 6, 2025

**Title** Simple Broadcasted Operations for Atomic and Recursive Arrays with Minimal Dependencies

**Version** 0.0.0.9

**Description** Implements simple broadcasted operations for atomic and recursive arrays.

Besides linking to 'Rcpp',

'broadcast' does not depend on, vendor, link to, include, or otherwise use any external libraries;

'broadcast' was essentially made from scratch and can be installed out-of-the-box.

The broadcasted implementations include, but are not limited to, the following.

1) A more efficient and broadcasted version of ``abind()``, for binding arrays along an arbitrary dimension;

2) Relational operations (like ``==``, ``!=``, ``<``, ``>``, ``<=``, ``>=``; can also take into account Machine precision);

3) Arithmetic operations (like ``+``, ``-``, ``*``, ``/``, ``gcd``, ``^``, ``pmin()``, ``pmax()``);

4) Boolean combiner operations (like ``&``, ``|``, ``xor()``, ``nand``);

5) String distance, (in)equality, and concatenation operations;

6) A Broadcasted implementation of ``ifelse()``;

7) A Broadcasted apply-like function;

The broadcasted implementations strive to minimize computation time and memory usage (which is not just good for computer efficiency, but also for the environment).

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**Encoding** UTF-8

**LinkingTo** Rcpp

**Roxygen** list(markdown = TRUE)

**RoxygenNote** 7.3.2

**Depends** R (>= 4.2.0)

**Imports** Rcpp (>= 1.0.11)

**Suggests** data.table, tinytest, roxygen2, pkgdown, devtools, kableExtra

**URL** <https://github.com/tony-aw/broadcast>

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aaa00_broadcast_help	<i>broadcast: Simple Broadcasted Operations for Atomic and Recursive Arrays with Minimal Dependencies</i>
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## Description

**broadcast:**  
Simple Broadcasted Binding and Binary Operations for Atomic and Recursive Arrays with Minimal Dependencies.

Implements simple broadcasted operations for atomic and recursive arrays.

Besides linking to 'Rcpp', 'broadcast' does not depend on, vendor, link to, include, or otherwise use any external libraries; 'broadcast' was essentially made from scratch and can be installed out-of-the-box.

The broadcasted implementations include, but are not limited to, the following:

1. A more efficient and broadcasted version of `abind()`, for binding arrays along an arbitrary dimension;
2. Relational operations (like `==`, `!=`, `<`, `>`, `<=`, `>=`; can also take into account Machine precision);
3. Arithmetic operations (like `+`, `-`, `*`, `/`, `"gcd"`, `^`, `pmin()`, `pmax()`);
4. Boolean combiner operations (like `&`, `|`, `xor()`, `"nand"`);
5. String distance, (in)equality, and concatenation operations;
6. A Broadcasted implementation of `ifelse()`;
7. A Broadcasted apply-like function; The broadcasted implementations strive to minimize computation time and memory usage (which is not just good for computer efficiency, but also for the environment).

## Getting Started

An introduction and overview of the package can be found on the website.

## Methods and Functions

### Outer-like functions

'broadcast' provides a set of functions for binary, element-wise, outer operations with broadcasting. These functions use an API similar to the [outer](#) and [sweep](#) functions.

The following functions for type-specific binary operations are available:

- [bc.b](#): Boolean operations;
- [bc.i](#): integer (53bit) arithmetic and relational operations;
- [bc.d](#): decimal (64bit) arithmetic and relational operations;
- [bc.cplx](#): complex arithmetic and (in)equality operations;
- [bc.str](#): string (in)equality, concatenation, and distance operations;
- [bc.list](#): apply any 'R' function to 2 recursive arrays with broadcasting.

### Binding Implementations

'broadcast' provides 3 binding implementations: [bind\\_mat](#), [bind\\_array](#), and [bind\\_dt](#).

### General functions

'broadcast' also comes with 2 general broadcasted functions:

- [bc\\_ifelse](#): Broadcasted version of [ifelse](#).
- [bcapply](#): Broadcasted apply-like function.

### Other functions

'broadcast' also provides [type-casting](#) functions, which preserve names and dimensions - convenient for arrays.

## Author(s)

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## References

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

## Description

This help page gives additional details on the binding implementations in the 'broadcast' package.

## Empty inputs

If argument input has length 0, or it contains exclusively objects where one or more dimensions are 0, an error is returned.

If input has length 1, these functions simply return `input[[1L]]`.

## Differences with `abind()`, `rbind()`/`cbind()`

The API of `bind_array()` is inspired by the fantastic `abind::abind` function by Tony Plare & Richard Heiberger (2016).

But `bind_array()` differs considerably from `abind::abind` in the following ways:

- `bind_array()` differs from `abind::abind` in that it can handle recursive arrays properly (the `abind::abind` function would unlist everything to atomic arrays, ruining the structure).
- `bind_array()` allows for broadcasting, while `abind::abind` does not support broadcasting.
- `bind_array()` is generally faster than `abind::abind`, as `bind_array()` relies heavily on 'C' and 'C++' code.
- unlike `abind::abind`, `bind_array()` only binds (atomic/recursive) arrays and matrices. `bind_array()` does not attempt to convert things to arrays when they are not arrays, but will give an error instead.  
This saves computation time and prevents unexpected results.
- `bind_array()` has more streamlined naming options, compared to `abind::abind`.

`bind_mat()` is a modified version of `rbind/cbind`.

`bind_mat()` differs from `rbind/cbind` in the following ways:

- it has more streamlined naming options/
- `bind_mat()` gives an error when fractional recycling is attempted (like binding `1:3` with `1:10`).
- `bind` The primary differences is that

**Naming**

...

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array_replicate	<i>Replicate Array Dimensions</i>
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**Description**

The `array_replicate()` function replicates array dimensions until the specified dimension sizes are reached, and returns the array.

The various broadcasting functions recycle array dimensions virtually, meaning little to no additional memory is needed.

The `array_replicate()` function, however, physically replicates the dimensions of an array (and thus actually occupies additional memory space).

**Usage**

```
array_replicate(x, tdim)
```

**Arguments**

<code>x</code>	an atomic or recursive array or matrix.
<code>tdim</code>	an integer vector, giving the target dimension to reach.

**Value**

Returns the replicated array.

**Examples**

```
x <- matrix(1:9, 3,3)
colnames(x) <- LETTERS[1:3]
rownames(x) <- letters[1:3]
names(x) <- month.abb[1:9]
print(x)

array_replicate(x, c(3,3,2)) # replicate to larger size
```

bc.b

*Broadcasted Boolean Operations***Description**

The `bc.b()` function performs broadcasted Boolean operations on 2 logical (or 32bit integer) arrays.

Please note that these operations will treat the input as Boolean.

Therefore, something like `bc.b(1, 2, "==")` returns TRUE, because both 1 and 2 are TRUE when cast as Boolean.

**Usage**

```
bc.b(x, y, op)
```

**Arguments**

`x, y` conformable logical (or 32bit integer) arrays.

`op` a single string, giving the operator.  
Supported Boolean operators: `&`, `|`, `xor`, `nand`, `==`, `!=`, `<`, `>`, `<=`, `>=`.

**Value**

A logical array as a result of the broadcasted Boolean operation.

**Examples**

```
x.dim <- c(4:2)
x.len <- prod(x.dim)
x.data <- sample(c(TRUE, FALSE, NA), x.len, TRUE)
x <- array(x.data, x.dim)
y <- array(1:50, c(4,1,1))

bc.b(x, y, "&")
bc.b(x, y, "|")
bc.b(x, y, "xor")
bc.b(x, y, "nand")
bc.b(x, y, "==")
bc.b(x, y, "!=")
```

**Description**

The `bc.cplx()` function performs broadcasted complex numeric operations pairs of arrays.

Note that `bc.cplx()` uses more strict NA checks than base 'R':

If for an element of either `x` or `y`, either the real or imaginary part is NA or NaN, than the result of the operation for that element is necessarily NA.

**Usage**

```
bc.cplx(x, y, op)
```

**Arguments**

<code>x, y</code>	conformable atomic arrays of type complex.
<code>op</code>	a single string, giving the operator. Supported arithmetic operators: <code>+</code> , <code>-</code> , <code>*</code> , <code>/</code> . Supported relational operators: <code>==</code> , <code>!=</code> .

**Value**

For arithmetic operators:

A complex array as a result of the broadcasted arithmetic operation.

For relational operators:

A logical array as a result of the broadcasted relational comparison.

**Examples**

```
x.dim <- c(4:2)
x.len <- prod(x.dim)
gen <- function() sample(c(rnorm(10), NA, NA, NaN, NaN, Inf, Inf, -Inf, -Inf))
x <- array(gen() + gen() * -1i, x.dim)
y <- array(gen() + gen() * -1i, c(4,1,1))

bc.cplx(x, y, "==")
bc.cplx(x, y, "!=")

bc.cplx(x, y, "+")

bc.cplx(array(gen() + gen() * -1i), array(gen() + gen() * -1i), "==")
bc.cplx(array(gen() + gen() * -1i), array(gen() + gen() * -1i), "!=")

x <- gen() + gen() * -1i
y <- gen() + gen() * -1i
```

```
out <- bc.cplx(array(x), array(y), "*")
cbind(x, y, x*y, out)
```

bc.d

*Broadcasted Decimal Numeric Operations*

## Description

The `bc.d()` function performs broadcasted decimal numeric operations on 2 numeric or logical arrays.

`bc.num()` is an alias for `bc.d()`.

## Usage

```
bc.d(x, y, op, prec = sqrt(.Machine$double.eps))
```

```
bc.num(x, y, op, prec = sqrt(.Machine$double.eps))
```

## Arguments

<code>x, y</code>	conformable logical or numeric arrays.
<code>op</code>	a single string, giving the operator. Supported arithmetic operators: <code>+</code> , <code>-</code> , <code>*</code> , <code>/</code> , <code>^</code> , <code>pmin</code> , <code>pmax</code> . Supported relational operators: <code>==</code> , <code>!=</code> , <code>&lt;</code> , <code>&gt;</code> , <code>&lt;=</code> , <code>&gt;=</code> , <code>d==</code> , <code>d!=</code> , <code>d&lt;</code> , <code>d&gt;</code> , <code>d&lt;=</code> , <code>d&gt;=</code> .
<code>prec</code>	a single number between 0 and 0.1, giving the machine precision to use. Only relevant for the following operators: <code>d==</code> , <code>d!=</code> , <code>d&lt;</code> , <code>d&gt;</code> , <code>d&lt;=</code> , <code>d&gt;=</code> See the <code>d==</code> , <code>d!=</code> , <code>d&lt;</code> , <code>d&gt;</code> , <code>d&lt;=</code> , <code>d&gt;=</code> operators from the 'tinycodet' package for details.

## Value

For arithmetic operators:

A numeric array as a result of the broadcasted decimal arithmetic operation.

For relational operators:

A logical array as a result of the broadcasted decimal relational comparison.

## Examples

```
x.dim <- c(4:2)
x.len <- prod(x.dim)
x.data <- sample(c(NA, 1.1:1000.1), x.len, TRUE)
x <- array(x.data, x.dim)
y <- array(1:50, c(4,1,1))
```



```

bc.d(x, y, "+")
bc.d(x, y, "-")
bc.d(x, y, "*")
bc.d(x, y, "/")
bc.d(x, y, "^")

bc.d(x, y, "==")
bc.d(x, y, "!=")
bc.d(x, y, "<")
bc.d(x, y, ">")
bc.d(x, y, "<=")
bc.d(x, y, ">=")

```

bc.i

*Broadcasted Integer Numeric Operations with Extra Overflow Protection*

## Description

The `bc.i()` function performs broadcasted integer numeric operations on 2 numeric or logical arrays.

Please note that these operations will treat the input as 53bit integers, and will efficiently truncate when necessary.

Therefore, something like `bc.i(1, 1.5, "==")` returns TRUE, because `trunc(1.5)` equals 1.

## Usage

```
bc.i(x, y, op)
```

## Arguments

<code>x, y</code>	conformable logical or numeric arrays.
<code>op</code>	a single string, giving the operator. Supported arithmetic operators: +, -, *, gcd, ^, pmin, pmax. Supported relational operators: ==, !=, <, >, <=, >=.

## Value

For arithmetic operators:

A numeric array of whole numbers, as a result of the broadcasted arithmetic operation.

Base 'R' supports 53 bit integers, which thus range from approximately -9 quadrillion to +9 quadrillion.

Values outside of this range will be returned as -Inf or Inf, as an extra protection against integer overflow.

For relational operators:

A logical array as a result of the broadcasted integer relational comparison.

**Examples**

```

x.dim <- c(4:2)
x.len <- prod(x.dim)
x.data <- sample(c(NA, 1.1:1000.1), x.len, TRUE)
x <- array(x.data, x.dim)
y <- array(1:50, c(4,1,1))

bc.i(x, y, "+")
bc.i(x, y, "-")
bc.i(x, y, "*")
bc.i(x, y, "gcd") # greatest common divisor
bc.i(x, y, "^")

bc.i(x, y, "==")
bc.i(x, y, "!=")
bc.i(x, y, "<")
bc.i(x, y, ">")
bc.i(x, y, "<=")
bc.i(x, y, ">=")

```

bc.list

*Broadcasted Operations for Recursive Arrays***Description**

The `bc.list()` function performs broadcasted operations on 2 Recursive arrays.

**Usage**

```
bc.list(x, y, f)
```

**Arguments**

<code>x, y</code>	conformable Recursive arrays (i.e. arrays of type <code>list</code> ).
<code>f</code>	a function that takes in exactly <b>2</b> arguments, and <b>returns</b> a result that can be stored in a single element of a list.

**Value**

A recursive array.

**Examples**

```

x.dim <- c(c(10, 2,2))
x.len <- prod(x.dim)

gen <- function(n) sample(list(letters, month.abb, 1:10), n, TRUE)

x <- array(gen(10), x.dim)
y <- array(gen(10), c(10,1,1))

```

```
bc.list(
  x, y,
  \(x, y)c(length(x) == length(y), typeof(x) == typeof(y))
)
```

---

bc.str

*Broadcasted String Operations*


---

## Description

The `bc.str()` function performs broadcasted string operations on pairs of arrays.

## Usage

```
bc.str(x, y, op)
```

## Arguments

<code>x, y</code>	conformable atomic arrays of typee character.
<code>op</code>	a single string, giving the operator. Supported concatenation operators: +. Supported relational operators: ==, !=. Supported distance operators: levenshtein.

## Value

For concatenation operation:

A character array as a result of the broadcasted concatenation operation.

For relational operation:

A logical array as a result of the broadcasted relational comparison.

For distance operation:

An integer array as a result of the broadcasted distance measurement.

## Examples

```
# string concatenation:
x <- array(letters, c(10, 2, 1))
y <- array(letters, c(10,1,1))
bc.str(x, y, "+")

# string (in)equality:
bc.str(array(letters), array(letters), "==")
bc.str(array(letters), array(letters), "!=")
```

```
# string distance (Levenshtein):
x <- array(month.name, c(12, 1))
y <- array(month.abb, c(1, 12))
out <- bc.str(x, y, "levenshtein")
dimnames(out) <- list(month.name, month.abb)
print(out)
```

---

**bcapply**
*Apply a Function to 2 Broadcasted Arrays*


---

**Description**

The `bcapply()` function applies a function to 2 arrays with broadcasting.

**Usage**

```
bcapply(x, y, f, v = "list")
```

**Arguments**

<code>x, y</code>	conformable atomic or recursive arrays.
<code>f</code>	a function that takes in exactly <b>2</b> arguments, and <b>returns</b> a result that can be stored in a single element of a recursive or atomic array.
<code>v</code>	a single string, giving the scalar type for a single iteration. If NULL or "list" (default), the result will be a recursive array. If it is certain that, for every iteration, <code>f()</code> always results in a <b>single atomic scalar</b> , the user can specify the type in <code>v</code> to pre-allocate the result. Pre-allocating the results leads to slightly faster and more memory efficient code. NOTE: Incorrectly specifying <code>v</code> leads to undefined behaviour.

**Value**

An atomic or recursive array with dimensions `bc_dim(x, y)`.

**Examples**

```
x.dim <- c(c(10, 2, 2))
x.len <- prod(x.dim)

gen <- function(n) sample(list(letters, month.abb, 1:10), n, TRUE)

x <- array(gen(10), x.dim)
y <- array(gen(10), c(10, 1, 1))

f <- function(x, y) list(x, y)
bcapply(x, y, f)
```

---

bc_dim	<i>Predict Broadcasted dimensions</i>
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---

**Description**

bc\_dim(x, y) gives the dimensions an array would have, as the result of an broadcasted binary element-wise operation between 2 arrays x and y.

**Usage**

```
bc_dim(x, y)
```

**Arguments**

x, y                      an atomic or recursive array.

**Value**

Returns the recycled array.

**Examples**

```
x.dim <- c(4:2)
x.len <- prod(x.dim)
x.data <- sample(c(TRUE, FALSE, NA), x.len, TRUE)
x <- array(x.data, x.dim)
y <- array(1:50, c(4,1,1))

dim(bc.b(x, y, "&")) == bc_dim(x, y)
dim(bc.b(x, y, "|")) == bc_dim(x, y)
```

---

bc_ifelse	<i>Broadcasted Ifelse</i>
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---

**Description**

The bc\_ifelse() function performs a broadcasted form of [ifelse](#).

**Usage**

```
bc_ifelse(cond, yes, no)
```

**Arguments**

cond                      logical vector or array with the length equal to prod(bc\_dim(yes, no)).  
 yes, no                   conformable arrays of the same type.  
                          All atomic types (see [atomic](#)) are supported.  
                          Recursive arrays of type list are also supported.

## Value

The output, here referred to as `out`, will be an array of the same type as `yes` and `no`.  
After broadcasting `yes` against `no`, given any element index `i`, the following will hold for the output:

- when `cond[i] == TRUE`, `out[i]` is `yes[i]`;
- when `cond[i] == FALSE`, `out[i]` is `no[i]`;
- when `cond[i]` is `NA`, `out[i]` is `NA` when `yes` and `no` are atomic, and `out[i]` is `list(NULL)` when `yes` and `no` are recursive.

## Examples

```
x.dim <- c(c(10, 2, 2))
x.len <- prod(x.dim)

gen <- function(n) sample(list(letters, month.abb, 1:10), n, TRUE)

x <- array(gen(10), x.dim)
y <- array(gen(10), c(10, 1, 1))

cond <- bc.list(
  x, y,
  \(x, y) c(length(x) == length(y) && typeof(x) == typeof(y))
) |> as_bool()

bc_ifelse(cond, yes = x, no = y)
```

---

bind

*Dimensional Binding of Objects*

---

## Description

The `bind_` implementations provide dimensional binding functionalities.

The following implementations are available:

- `bind_mat()` binds dimensionless (atomic/recursive) vectors and (atomic/recursive) matrices row- or column-wise.  
Allows for recycling.
- `bind_array()` binds (atomic/recursive) arrays and (atomic/recursive) matrices.  
Allows for broadcasting.
- `bind_dt()` binds `data.tables` and other `data.frame`-like objects.  
This function is only available if the 'data.table' package is installed.  
Returns a `data.table`.  
Faster than `do.call(cbind, ...)` or `do.call(rbind, ...)` for regular `data.frame` objects.

Note that the naming convention of the binding implementations here is "bind\_" followed by the **resulting class** (abbreviated).

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

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

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

## Usage

```
bind_mat(input, along, name_deparse = TRUE, comnames_from = 1L)
```

```
bind_array(
  input,
  along,
  revalong,
  ndim2bc = 1L,
  name_along = TRUE,
  comnames_from = 1L
)
```

```
bind_dt(input, along, ...)
```

## Arguments

- |               |  |
|---------------|--|
| input         | a list of only the appropriate objects.<br>If input is named, its names will be used for the names of dimension along of the output, as far as possible.   |
| along         | a single integer, indicating the dimension along which to bind the dimensions.<br>I.e. use <code>along = 1</code> for row-binding, <code>along = 2</code> for column-binding, etc.<br>For arrays, additional flexibility is available: <ul style="list-style-type: none"> <li>• Specifying <code>along = 0</code> will bind the arrays on a new dimension before the first, making <code>along</code> the new first dimension.</li> <li>• Specifying <code>along = N + 1</code>, with <code>N = max(lst.ndim(input))</code>, will create an additional dimension (<code>N + 1</code>) and bind the arrays along that new dimension.</li> </ul> |
| name_deparse  | Boolean, for <code>bind_mat()</code> .<br>Indicates if dimension <code>along</code> should be named.<br>Uses the naming method from <code>rbind/cbind</code> itself.   |
| comnames_from | either integer scalar or <code>NULL</code> , for <code>bind_mat()</code> and <code>bind_array()</code> .<br>Indicates which object in <code>input</code> should be used for naming the shared dimension.<br>If <code>NULL</code> , no communal names will be given.<br>For example:<br>When binding columns of matrices, the matrices will share the same rownames.<br>Using <code>comnames_from = 10</code> will then result in <code>bind_array()</code> using <code>rownames(input[[10]])</code> for the rownames of the output.  |
| revalong      | for <code>bind_array()</code> only.<br>Same as <code>along</code> , but counting backwards.<br>I.e. <code>revalong = 0</code> is equivalent to <code>along = N+1</code> , and <code>revalong = N+1</code> is equivalent to <code>along = 0</code> ;<br>with <code>N = max(lst.ndim(input))</code> .  |

ndim2bc	non-negative integer, for <code>bind_array</code> only. Specify here the maximum number of dimensions that are allowed to be broadcasted when binding arrays. If <code>ndim2bc = 0L</code> , <b>no</b> broadcasting will be allowed at all.
name_along	Boolean, for <code>bind_array()</code> . Indicates if dimension along should be named.
...	arguments to be passed to <a href="#">rbindlist</a> .

## Details

For in-depth information about the binding implementations in the 'broadcast' package, please refer to [broadcast\\_bind](#).

## Value

The bound 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

```
# bind_array ====

# here, atomic and recursive arrays are mixed,
# resulting in recursive arrays

# creating the arrays
x <- c(
  lapply(1:3, \(x)sample(c(TRUE, FALSE, NA))),
  lapply(1:3, \(x)sample(1:10)),
  lapply(1:3, \(x)rnorm(10)),
  lapply(1:3, \(x)sample(letters))
)
x <- matrix(x, 4, 3, byrow = TRUE)
dimnames(x) <- list(letters[1:4], LETTERS[1:3])
print(x)

y <- matrix(1:12, 4, 3)
print(y)

# binding the arrays
input <- list(x = x, y = y)
bind_array(input, along = 0L) # binds on new dimension before first
bind_array(input, along = 1L) # binds on first dimension (i.e. rows)
bind_array(input, along = 2L)
bind_array(input, along = 3L) # bind on new dimension after last

bind_array(input, revalong = 0L) # binds on new dimension after last
```



```

bind_array(input, revalong = 1L) # binds on last dimension (i.e. columns)
bind_array(input, revalong = 2L)
bind_array(input, revalong = 3L) # bind on new dimension before first

# binding, with empty arrays
emptyarray <- array(numeric(0L), c(0L, 3L))
dimnames(emptyarray) <- list(NULL, paste("empty", 1:3))
print(emptyarray)
input <- list(x = x, y = emptyarray)
bind_array(input, along = 1L, comnames_from = 2L) # row-bind

#####

# bind_mat ====

# here, atomic and recursive matrices are mixed,
# resulting in a recursive matrix

x <- c(
  lapply(1:3, \(x)sample(c(TRUE, FALSE, NA))),
  lapply(1:3, \(x)sample(1:10)),
  lapply(1:3, \(x)rnorm(10)),
  lapply(1:3, \(x)sample(letters))
)
x <- matrix(x, 4, 3, byrow = TRUE)
dimnames(x) <- list(letters[1:4], LETTERS[1:3])
print(x)

y <- matrix(1:12, 4, 3)
print(y)

bind_mat(list(x = x, y = y), 2L)

#####

# bind_dt ====

x <- data.frame(a = 1:12, b = month.abb) # data.frame
y <- data.table::data.table(a = 1:12, b = month.abb) # data.table

bind_dt(list(x = x, y = y), 2L) # column bind

bind_dt(list(x = x, y = y), 1L) # row bind

```

**Description**

`ndim()` returns the number of dimensions of an object.  
`lst.ndim()` returns the number of dimensions of every list-element.  
`lst.typeof()` returns the (internal) type of every list-element.  
`len()` is an alias for `length`.  
`lst.len()` is an alias for `lengths`.

These functions were all designed to be efficient.

**Usage**

```
ndim(x)
```

```
lst.ndim(x)
```

```
lst.typeof(x)
```

**Arguments**

<code>x</code>	an object. For functions starting with <code>lst.</code> , <code>x</code> must be a list (i.e. recursive vector or recursive array).
----------------	---

**Value**

An integer scalar

**Examples**

```

# bind_array ====

# here, atomic and recursive arrays are mixed,
# resulting in recursive arrays

# creating the arrays
x <- c(
  lapply(1:3, \(x)sample(c(TRUE, FALSE, NA))),
  lapply(1:3, \(x)sample(1:10)),
  lapply(1:3, \(x)rnorm(10)),
  lapply(1:3, \(x)sample(letters))
)
x <- matrix(x, 4, 3, byrow = TRUE)
dimnames(x) <- list(letters[1:4], LETTERS[1:3])
print(x)

y <- matrix(1:12, 4, 3)
print(y)

# binding the arrays
input <- list(x = x, y = y)
bind_array(input, along = 0L) # binds on new dimension before first
bind_array(input, along = 1L) # binds on first dimension (i.e. rows)

```

```

bind_array(input, along = 2L)
bind_array(input, along = 3L) # bind on new dimension after last

bind_array(input, revalong = 0L) # binds on new dimension after last
bind_array(input, revalong = 1L) # binds on last dimension (i.e. columns)
bind_array(input, revalong = 2L)
bind_array(input, revalong = 3L) # bind on new dimension before first

# binding, with empty arrays
emptyarray <- array(numeric(0L), c(0L, 3L))
dimnames(emptyarray) <- list(NULL, paste("empty", 1:3))
print(emptyarray)
input <- list(x = x, y = emptyarray)
bind_array(input, along = 1L, comnames_from = 2L) # row-bind

#####

# bind_mat ====

# here, atomic and recursive matrices are mixed,
# resulting in a recursive matrix

x <- c(
  lapply(1:3, \(x)sample(c(TRUE, FALSE, NA))),
  lapply(1:3, \(x)sample(1:10)),
  lapply(1:3, \(x)rnorm(10)),
  lapply(1:3, \(x)sample(letters))
)
x <- matrix(x, 4, 3, byrow = TRUE)
dimnames(x) <- list(letters[1:4], LETTERS[1:3])
print(x)

y <- matrix(1:12, 4, 3)
print(y)

bind_mat(list(x = x, y = y), 2L)

#####

# bind_dt ====

x <- data.frame(a = 1:12, b = month.abb) # data.frame
y <- data.table::data.table(a = 1:12, b = month.abb) # data.table

bind_dt(list(x = x, y = y), 2L) # column bind

bind_dt(list(x = x, y = y), 1L) # row bind

```

## Description

Type casting usually strips away attributes of objects.

The functions provided here preserve dimensions, dimnames, and names, which may be more convenient for arrays and array-like objects.

The functions are as follows:

- `as_bool()`: converts object to atomic type logical (TRUE, FALSE, NA).
- `as_int()`: converts object to atomic type integer.
- `as_dbl()`: converts object to atomic type double (AKA numeric).
- `as_chr()`: converts object to atomic type character.
- `as_cplx()`: converts object to atomic type complex.
- `as_raw()`: converts object to atomic type raw.
- `as_list()`: converts object to recursive type list.

`as_num()` is an alias for `as_dbl()`.

`as_str()` is an alias for `as_chr()`.

See also [typeof](#).

## Usage

```
as_bool(x, ...)
```

```
as_int(x, ...)
```

```
as_dbl(x, ...)
```

```
as_num(x, ...)
```

```
as_chr(x, ...)
```

```
as_str(x, ...)
```

```
as_cplx(x, ...)
```

```
as_raw(x, ...)
```

```
as_list(x, ...)
```

## Arguments

`x` an R object.  
`...` further arguments passed to or from other methods.

## Value

The converted object.

## Examples

```
# matrix example ====
x <- matrix(sample(-1:28), ncol = 5)
colnames(x) <- month.name[1:5]
rownames(x) <- month.abb[1:6]
names(x) <- c(letters[1:20], LETTERS[1:10])
print(x)

as_bool(x)
as_int(x)
as_dbl(x)
as_chr(x)
as_cplx(x)
as_raw(x)

#####

# factor example ====
x <- factor(month.abb, levels = month.abb)
names(x) <- month.name
print(x)

as_bool(as_int(x) > 6)
as_int(x)
as_dbl(x)
as_chr(x)
as_cplx(x)
as_raw(x)
```

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