

Package ‘Brobdingnag’

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Type Package

Title Very Large Numbers in R

Version 1.2-9

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Depends R (>= 2.13.0), methods, Matrix (>= 1.5-0)

Description Very large numbers in R. Real numbers are held using their natural logarithms, plus a logical flag indicating sign. Functionality for complex numbers is also provided. The package includes a vignette that gives a step-by-step introduction to using S4 methods.

Suggests cubature, testthat

License GPL

Repository CRAN

URL <https://github.com/RobinHankin/Brobdingnag>

NeedsCompilation no

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Brobdingnag-package *Very Large Numbers in R*

Description

Very large numbers in R. Real numbers are held using their natural logarithms, plus a logical flag indicating sign. Functionality for complex numbers is also provided. The package includes a vignette that gives a step-by-step introduction to using S4 methods.

Details

The DESCRIPTION file:

```

Package:      Brobdingnag
Type:         Package
Title:        Very Large Numbers in R
Version:      1.2-9
Authors@R:   person(given=c("Robin", "K. S."), family="Hankin", role = c("aut","cre"), email="hankin.robin@gmail.com",
Maintainer:   Robin K. S. Hankin <hankin.robin@gmail.com>
Depends:     R (>= 2.13.0), methods, Matrix (>= 1.5-0)
Description:  Very large numbers in R. Real numbers are held using their natural logarithms, plus a logical flag indicating sign.
Suggests:    cubature, testthat
License:     GPL
Repository:   CRAN
URL:         https://github.com/RobinHankin/Brobdingnag
Author:      Robin K. S. Hankin [aut, cre] (<https://orcid.org/0000-0001-5982-0415>)

```

Index of help topics:

```

Arith-methods                      Methods for Function Arith in package
                                    Brobdingnag

```

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brob-class	Class "brob"
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brobmat.mult	Brobdingagian matrix arithmetic
cbrob	Combine Brobdingnagian vectors
getP	Get and set methods for brob objects
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Real numbers are represented by two objects: a real, holding the logarithm of their absolute values; and a logical, indicating the sign. Multiplication and exponentiation are easy: the challenge is addition. This is achieved using the (trivial) identity $\log(e^x + e^y) = x + \log(1 + e^{y-x})$ where, WLOG, $y < x$.

Complex numbers are stored as a pair of brobs: objects of class glub.

The package is a simple example of S4 methods.

However, it *could* be viewed as a cautionary tale: the underlying R concepts are easy yet the S4 implementation is long and difficult. I would not recommend using S4 methods for a package as simple as this; S3 methods would have been perfectly adequate. I would suggest that S4 methods should only be used when S3 methods are *demonstrably* inadequate.

Author(s)

NA

Maintainer: Robin K. S. Hankin <hankin.robin@gmail.com>

References

R. K. S. Hankin 2007. "Very Large Numbers in R: Introducing Package Brobdingnag". R News, volume 7, number 3, pages 15-16

Examples

```

googol <- as.brob(10)^100

googol
googol + googol/2

1/(googol + 1e99)

(1:10)^googol

googolplex <- 10^googol

googolplex

googolplex * googol # practically the same as googolplex (!)

```

Arith-methods

Methods for Function Arith in package Brobdingnag

Description

Methods for Arithmetic functions in package Brobdingnag: +, -, *, /, ^

Note

The unary arithmetic functions (viz “+” and “-”) do no coercion.

The binary arithmetic functions coerce numeric <op> brob to brob; and numeric <op> glub, complex <op> brob, and brob <op> glub, to glub.

Author(s)

Robin K. S. Hankin

Examples

```

x <- as.brob(1:10)
y <- 1e10

x+y

as.numeric((x+y)-1e10)

x^(1/y)

```

as.numeric	<i>Coerces to numeric or complex form</i>
------------	---

Description

Coerces an object of class brob to numeric, or an object of class glub to complex

Arguments

x	Object of class brob or glub
...	Further arguments (currently ignored)

Details

Function `as.numeric()` coerces a brob to numeric; if given a glub, the imaginary component is ignored (and a warning given).

Function `as.complex()` coerces to complex.

Note

If $|x|$ is greater than `.Machine$double.xmax`, then `as.numeric(x)` returns `Inf` or `-Inf` but no warning is given.

Author(s)

Robin K. S. Hankin

Examples

```
a <- as.brob(1:10)
a <- cbrob(a, as.brob(10)^1e26)
a
as.numeric(a)

as.complex(10i + a)
```

brob *Brobdingnagian numbers*

Description

Create, coerce to or test for a Brobdingnagian object

Usage

```
brob(x = double(), positive)
as.brob(x)
is.brob(x)
```

Arguments

x	Quantity to be tested, coerced in to Brobdingnagian form
positive	In function brob(), logical indicating whether the number is positive (actually, positive or zero)

Details

Function `as.brob()` is the user's workhorse: use this to coerce numeric vectors to brobs.

Function `is.brob()` tests for its arguments being of class brob.

Function `brob()` takes argument `x` and returns a brob formally equal to e^x ; set argument `positive` to `FALSE` to return $-e^x$. Thus calling function `exp(x)` simply returns `brob(x)`. This function is not really intended for the end user: it is confusing and includes no argument checking. In general numerical work, use function `as.brob()` instead, although be aware that if you really really want e^{10^7} , you should use `brob(1e7)`; this would be an **exact** representation.

Note

Real numbers are represented by two objects: a real, holding the logarithm of their absolute values; and a logical, indicating the sign. Multiplication and exponentiation are easy: the challenge is addition. This is achieved using the (trivial) identity $\log(e^x + e^y) = x + \log(1 + e^{y-x})$ where, WLOG, $y < x$.

Complex numbers are stored as a pair of brobs: objects of class `glub`.

The package is a simple example of S4 methods. However, it *could* be viewed as a cautionary tale: the underlying R concepts are easy yet the S4 implementation is long and difficult. I would not recommend using S4 methods for a package as simple as this; S3 methods would have been perfectly adequate. I would suggest that S4 methods should only be used when S3 methods are *demonstrably* inadequate.

The package has poor handling of NA and NaN. Currently, `as.brob(1) + as.brob(c(1, NA))` returns an error.

Author(s)

Robin K. S. Hankin

See Also

[glub](#)

Examples

```
googol <- as.brob(10)^100
googolplex <- 10^googol

(googolplex/googol) / googolplex
# Thus googolplex/googol == googolplex (!)

# use cbrob() instead of c() when Brobdingnagian numbers are involved:
cbrob(4,exp(as.brob(1e55)))
```

brob-class

Class "brob"

Description

The formal S4 class for Brobdingnagian numbers

Objects from the Class

Objects *can* be created by calls of the form `new("brob", ...)` but this is not encouraged. Use functions `brob()` and, especially, `as.brob()` instead.

Slots

x: Object of class "numeric" holding the log of the absolute value of the number to be represented
positive: Object of class "logical" indicating whether the number is positive (see Note, below)

Extends

Class "swift", directly.

Note

Slot `positive` indicates non-negativity, as zero is conventionally considered to be "positive".

Author(s)

Robin K. S. Hankin

See Also

[glub-class](#), [swift-class](#)

Examples

```
new("brob",x=5,positive=TRUE) # not intended for the user
as.brob(5) # Standard user-oriented idiom
```

brobmat

Brobdingnagian matrices

Description

Basic matrix arithmetic for Brobdingnagian numbers. Matrix addition, multiplication extraction and replacement implemented but not the determinant or matrix inverse.

Usage

```
brobmat(..., positive)
newbrobmat(x,positive)
as.brobmat(x)
is.brobmat(x)
brobmat_to_brob(x)
diag(x,...)
## S3 method for class 'brobmat'
print(x,...)
t(x,...)
```

Arguments

x	Argument
...	Further arguments
positive	Logical, indicating whether an element is positive

Details

Basic arithmetic for Brobdingnagian matrices.

Function `brobmat()` is like `brob()` in that it interprets its first argument as the exponent (but creates a matrix). Function `as.brobmat()` coerces a numeric matrix to a `brobmat`.

Value

Generally return a brobmat or brob.

Author(s)

Robin K. S. Hankin

Examples

```
brobmat(-10:19,5,6)
as.brobmat(matrix(-10:19,5,6))
```

brobmat-class	<i>Class "brobmat"</i>
---------------	------------------------

Description

The brobmat class provides basic Brobdingnagian arithmetic for matrices.

Objects from the Class

Objects can be created by calls of the form `new("brobmat", ...)`, although functions `brobmat()`, `as.brobmat()` are more user-friendly.

Slots

x: Object of class "matrix" that specifies the exponent
positive: Object of class "logical" that specifies the sign

Methods

```
[ signature(x = "brobmat", i = "ANY", j = "ANY"): ...
[ signature(x = "brobmat", i = "index", j = "index"): ...
[ signature(x = "brobmat", i = "index", j = "missing"): ...
[ signature(x = "brobmat", i = "missing", j = "index"): ...
[ signature(x = "brobmat", i = "missing", j = "missing"): ...
[ signature(x = "brobmat", i = "matrix", j = "missing"): ...
[<- signature(x = "brobmat", i = "index", j = "index"): ...
[<- signature(x = "brobmat", i = "index", j = "missing"): ...
[<- signature(x = "brobmat", i = "missing", j = "index"): ...
[<- signature(x = "brobmat", i = "matrix", j = "missing"): ...
[<- signature(x = "brobmat", i = "missing", j = "missing"): ...
```

```

%% signature(x = "ANY", y = "brobmat"): ...
%% signature(x = "brobmat", y = "ANY"): ...
%% signature(x = "brobmat", y = "brobmat"): ...
Arith signature(e1 = "ANY", e2 = "brobmat"): ...
Arith signature(e1 = "brob", e2 = "brobmat"): ...
Arith signature(e1 = "brobmat", e2 = "ANY"): ...
Arith signature(e1 = "brobmat", e2 = "brob"): ...
Arith signature(e1 = "brobmat", e2 = "brobmat"): ...
Arith signature(e1 = "brobmat", e2 = "missing"): ...
as.matrix signature(x = "brobmat"): ...
as.vector signature(x = "brobmat"): ...
coerce signature(from = "brobmat", to = "matrix"): ...
colnames signature(x = "brobmat"): ...
colnames<- signature(x = "brobmat"): ...
Compare signature(e1 = "ANY", e2 = "brobmat"): ...
Compare signature(e1 = "brobmat", e2 = "ANY"): ...
Compare signature(e1 = "brobmat", e2 = "brobmat"): ...
diag signature(x = "brobmat"): ...
dimnames signature(x = "brobmat"): ...
dimnames<- signature(x = "brobmat"): ...
getP signature(x = "brobmat"): ...
getX signature(x = "brobmat"): ...
length signature(x = "brobmat"): ...
Math signature(x = "brobmat"): ...
ncol signature(x = "brobmat"): ...
nrow signature(x = "brobmat"): ...
rownames signature(x = "brobmat"): ...
rownames<- signature(x = "brobmat"): ...
show signature(object = "brobmat"): ...
t signature(x = "brobmat"): ...

```

Author(s)

Robin K. S. Hankin

References

Brodingnag R News paper

See Also

[as.brob](#), [brob](#)

Examples

```
showClass("brobmat")
```

brobmat.mult	<i>Brobdingagian matrix arithmetic</i>
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Description

Basic arithmetic for Brobdingnagian matrices

Usage

```
brobmat.mult(e1, e2)  
brobmat.add(e1, e2)  
brobmat.mult(e1, e2)  
brobmat.power(e1, e2)  
brobmat.inverse(e1)  
brobmat.greater(e1, e2)  
brobmat.equal(e1, e2)  
getat(e1,e2)
```

Arguments

e1, e2 Arguments coerced to brobmat

Details

These functions are helper functions used by the brobmat Arith group and are not designed to be user-friendly. Function `getat()` is a helper function that sets attributes such as `dimnames` of returned values.

Value

Return a brobmat, or logical for the comparison operators.

Author(s)

Robin K. S. Hankin

Examples

```

a <- brobmat(1:54,6,9)
rownames(a) <- letters[1:6]
a + 1e30
a-a

b <- as.brobmat(matrix(rnorm(27),9,3))
colnames(b) <- month.abb[1:3]

a %*% b

```

cbrob

Combine Brobdingnagian vectors

Description

Combine Brobdingnagian or Glubdubbribian vectors through concatenation

Usage

```
cbrob(x, ...)
```

Arguments

x	Brobdingnagian vector
...	Other arguments coerced to brob form

Details

If any argument has class `glub`, all arguments are coerced to `glubs`. Otherwise, if any argument has class `brob`, all arguments are coerced to `brobs`.

Function `cbrob()` operates recursively, calling `.cPair()` repeatedly. Function `.cPair()` uses S4 method dispatch to call either `.Brob.cpair()` or `.Glub.cpair()` according to the classes of the arguments.

Note

As of R-2.4.0, it is apparently not possible to use S4 methods to redefine `c()` to coerce to class `brob` form and concatenate as expected. This would seem to be a reasonable interpretation of `c()` from the user's perspective.

Conceptually, the operation is simple: concatenate the value slot and the positive slot separately, then call `brob()` on the two resulting vectors. When concatenating `glub` objects, the real and imaginary components (being `brobs`) are concatenated using `.Brob.cpair()`

The choice of name—`cbrob()`—is not entirely logical. Because it operates consistently on `brob` and `glub` objects, it might be argued that `cSwift()` would be a more appropriate name.

Author(s)

Robin K. S. Hankin; original idea due to John Chambers

Examples

```
a <- as.brob(2)^1e-40
cbrob(1:4, 4:1, a)
cbrob(1:4, a, 1i)
```

Compare-methods

Methods for Function Compare in Package Brobdingnag

Description

Methods for comparison (greater than, etc) in package Brobdingnag

Note

As for `min()` and `max()`, comparison is not entirely straightforward in the presence of NAs.

The low-level workhorses are `.Brob.equal()` for equality and `.Brob.greater()` for ‘strictly greater than’. All other comparisons are calculated by combining these two.

Comparison [function `.Brob.compare()`] explicitly tests for a zero length argument and if given one returns `logical(0)` to match base behaviour.

Examples

```
a <- as.brob(10)^(0.5 + 97:103)
a < 1e100
```

Complex

Real and imaginary manipulation

Description

Get or set real and imaginary components of brobs or glubs.

Usage

```
## S4 method for signature 'glub'
Re(z)
## S4 method for signature 'glub'
Im(z)
## S4 method for signature 'glub'
Mod(z)
## S4 method for signature 'glub'
Conj(z)
## S4 method for signature 'glub'
Arg(z)
Re(z) <- value
Im(z) <- value
```

Arguments

z	object of class <code>glub</code> (or, in the case of <code>Im<-()</code> or <code>Im(z) <- value</code> , class <code>brob</code>)
value	object of class <code>numeric</code> or <code>brob</code>

Value

Functions `Re()` and `Im()` return an object of class `brob`; functions `Re<-()` and `Im<-()` return an object of class `glub`

Author(s)

Robin K. S. Hankin

Examples

```
a <- cbrob(1:10, brob(1e100))
Im(a) <- 11:1
a
```

Extract.brob

Extract or Replace Parts of brobs or glubs

Description

Methods for "[" and "[<-", i.e., extraction or subsetting of brobs and glubs.

Arguments

x	Object of class <code>brob</code> or <code>glub</code>
i	elements to extract or replace
value	replacement value

Value

Always returns an object of the same class as x.

Note

If x is a numeric vector and y a brob, one might expect typing `x[1] <- y` to result in x being a brob. This is impossible, according to John Chambers.

Author(s)

Robin K. S. Hankin

Examples

```
a <- as.brob(10)^c(-100,0,100,1000,1e32)
a[4]
a[4] <- 1e100
a
```

getP

Get and set methods for brob objects

Description

Get and set methods for brobs: sign and value

Usage

```
getP(x)
getX(x)
sign(x) <- value
```

Arguments

x	Brobdingnagian object
value	In function <code>sign<-()</code> , Boolean specifying whether the brob object is positive

Author(s)

Robin K. S. Hankin

See Also

[brob](#)

Examples

```
x <- as.brob(-10:10)
sign(x) <- TRUE
```

glub	<i>Glubbdubdribian numbers: complex numbers with Brobdingnagian real and imaginary parts</i>
------	--

Description

Create, coerce to or test for a Glubbdubdribian object

Usage

```
glub(real = double(), imag = double())
as.glub(x)
is.glub(x)
```

Arguments

real, imag	Real and imaginary components of complex number: must be Brobdingnagian numbers
x	object to be coerced to or tested for Glubbdubdribian form

Details

A *Glubbdubdribian* number is the Brobdingnagian equivalent of a complex number.

Function `glub()` takes two arguments that are coerced to Brobdingnagian numbers and returns a Glubbdubdribian number. This function is not really intended for the end user: it is confusing and includes no argument checking. Use function `as.glub()` instead.

Function `as.glub()` is the user's workhorse: use this to coerce numeric or complex vectors to Glubbdubdribian form.

Function `is.glub()` tests for its arguments being Glubbdubdribian.

Note

Function `glub()` uses recycling inherited from `cbind()`.

Author(s)

Robin K. S. Hankin

See Also

[brob](#)

Examples

```

a <- as.glub(1:10 + 5i)
a^2 - a*a

f <- function(x){sin(x) +x^4 - 1/x}
as.complex(f(a)) - f(as.complex(a)) # should be zero (in the first
# term, f() works with glubs and coerces to
# complex; in the second, f()
# works with complex numbers directly)

```

glub-class

*Class "glub"***Description**

Complex Brobdingnagian numbers

Objects from the Class

A glub object holds two slots, both brobs, representing the real and imaginary components of a complex vector.

Slots

real: Object of class "brob" representing the real component
imag: Object of class "brob" representing the imaginary component

Extends

Class "swift", directly.

Methods

.cPair signature(x = "brob", y = "glub"): ...
.cPair signature(x = "ANY", y = "glub"): ...
.cPair signature(x = "glub", y = "glub"): ...
.cPair signature(x = "glub", y = "ANY"): ...
.cPair signature(x = "glub", y = "brob"): ...
Im<- signature(x = "glub"): ...
Re<- signature(x = "glub"): ...

Author(s)

Robin K. S. Hankin

See Also

[brob-class](#), [swift-class](#)

Examples

```
a <- as.brob(45)
new("glub", real=a, imag=a)

as.brob(5+5i) # standard R idiom; imaginary component discarded
as.glub(5+5i) # returns a Glubbubdribian object
```

index-class

Class "index"

Description

A virtual class for matrix extraction, copied from the `Matrix` package.

Objects from the Class

A virtual Class: No objects may be created from it.

Methods

```
[ signature(x = "brobmat", i = "index", j = "index"): ...
[ signature(x = "brobmat", i = "index", j = "missing"): ...
[ signature(x = "brobmat", i = "missing", j = "index"): ...
[<- signature(x = "brobmat", i = "index", j = "index"): ...
[<- signature(x = "brobmat", i = "index", j = "missing"): ...
[<- signature(x = "brobmat", i = "missing", j = "index"): ...
```

Author(s)

Bates and Maechler, I guess

References

Douglas Bates and Martin Maechler (2019). `Matrix: Sparse and Dense Matrix Classes and Methods`. R package version 1.2-18. <https://CRAN.R-project.org/package=Matrix>

See Also

[brobmat](#)

Examples

```
showClass("index")
```

infinite-methods *Infinite brobs and glubs*

Description

Brobdingnagian and Glubbudribian infinity

Usage

```
## S4 method for signature 'brob'  
is.infinite(x)  
## S4 method for signature 'glub'  
is.infinite(x)  
## S4 method for signature 'brob'  
is.finite(x)  
## S4 method for signature 'glub'  
is.finite(x)
```

Arguments

x vector of class brob or glub

Details

For a Brobdingnagian number, `is.infinite()` returns TRUE if the exponent is infinite.
A Glubbudribian number is infinite if either the real or imaginary component is infinite.
Function `is.finite()` is simply the logical negation of `is.infinite()`.

Author(s)

Robin K. S. Hankin

Examples

```
is.infinite(brob(c(1,4,Inf)))  
  
is.infinite(glub(3,Inf))  
is.infinite(glub(Inf,3))  
  
is.infinite(exp(1e300))  
is.infinite(brob(1e300))  
# (Brobdingnagian infinity is bigger than regular infinity ;-)
```

length-methods

Get lengths of brobs and glubs

Description

Get lengths of brob and glub vectors

Usage

```
## S4 method for signature 'brob'  
length(x)  
## S4 method for signature 'glub'  
length(x)
```

Arguments

x vector of class brob or glub

Author(s)

Robin K. S. Hankin

Examples

```
x <- as.brob(-10:10)  
length(x)
```

Logic

Logical operations on brobs

Description

Logical operations on brobs are not supported

Note

The S4 group generic “Logic” appeared in R-2.4.0-patched.

Carrying out logical operations in this group will call `.Brob.logic()`, which reports an error.

Negation, “!”, is not part of this group: attempting to negate a brob will not activate `.Brob.logic()`; an “invalid argument type” error is given instead.

Author(s)

Robin K. S. Hankin

Examples

```
## Not run:
!brob(10)

## End(Not run)
```

 Math

Various logarithmic and circular functions for brobs

Description

Various elementary functions for brobs

Arguments

x	Object of class brob (or sometimes glub)
base	In function log(), the base of the logarithm

Details

For brobs: apart from abs(), log(), exp(), sinh() and cosh(), these functions return f(as.numeric(x)) so are numeric; the exceptional functions return brobs.

For glubs: mostly direct transliteration of the appropriate formula; one might note that log(z) is defined as glub(log(Mod(x)), Arg(x)).

Author(s)

Robin K. S. Hankin

Examples

```
exp(as.brob(3000)) #exp(3000) is represented with zero error
```

 plot

Basic plotting of Brobs

Description

Plotting methods. Essentially, any brob is coerced to a numeric and any glub is coerced to a complex, and the argument or arguments are passed to plot().

Usage

```
plot(x, y, ...)
```

Arguments

<code>x,y</code>	Brob or glub
<code>...</code>	Further arguments passed to <code>plot()</code>

Author(s)

Robin K. S. Hankin

Examples

```
plot(as.brob(1:10))
```

Print

Methods for printing brobs and glubs

Description

Methods for printing brobs and glubs nicely using exponential notation

Usage

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

Arguments

<code>x</code>	An object of class brob or glub
<code>...</code>	Further arguments (currently ignored)

Author(s)

Robin K. S. Hankin

Examples

```
a <- as.brob(1:5)  
dput(a)  
a
```

sum

Various summary statistics for brobs and glubs

Description

Various summary statistics for brobs and glubs

Arguments

<code>x, ...</code>	Objects of class brob or, in the case of <code>sum()</code> and <code>prob()</code> , class glub
<code>na.rm</code>	Boolean, with default FALSE meaning to interpret NAs literally and TRUE meaning to ignore any such elements

Details

For a brob object, being NA is not entirely straightforward. The S4 method for `is.na` is too “strict” for some of the functions considered here. Consider `max(a)` where `a` includes only positive, fully specified, elements, and elements with known negative sign and exponents that include NA values. Here, `max(a)` is unambiguously determined.

Similar logic applies to `min()` and, by extension, `range()`.

Note

Function `prod()` is *very* slow for long glub vectors. It has to compute four Brobdingnagian products and two Brobdingnagian sums per element of its argument, and this takes a long time.

Author(s)

Robin K. S. Hankin

See Also

[is.na](#)

Examples

```
a <- as.brob(1:10)
max(cbrob(1:10, brob(NA, FALSE)))
```

`swift-class`*Class "swift"*

Description

A (virtual) class that extends brob and glub objects

Objects from the Class

A virtual Class: No objects may be created from it.

Methods

No methods defined with class "swift" in the signature.

Author(s)

Robin K. S. Hankin

See Also

[brob-class](#), [glub-class](#)

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