

Package ‘Brobdingnag’

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Type Package

Title Very large numbers in R

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Depends R (>= 2.13.0), methods,graphics

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Description Handles very large numbers in R. Real numbers are held using their natural logarithms, plus a logical flag indicating sign. The package includes a vignette that gives a step-by-step introduction to using S4 methods.

LazyLoad yes

License GPL

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R topics documented:

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|---------------------|--|
| Brobdingnag-package | <i>Brobdingnagian numbers: storing large numbers by their natural logarithms</i> |
|---------------------|--|

Description

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.

Details

| | |
|----------|-------------|
| Package: | Brobdingnag |
| Type: | Package |
| Version: | 1.0-1 |
| Date: | 2006-09-21 |
| License: | GPL |

The user should coerce numeric vectors to brobs using `as.brob()`. The 4 arithmetic operations, concatenation, trig functions, comparisons, and so forth, should operate on brobs transparently.

The basic low-level function is `brob()`, which takes two vectors: a double for the value and a logical for the sign (defaulting to positive). Given `x`, function `brob(x)` returns e^x .

Functions `as.glub()` and `glub()` perform analogous operations for the complex plane.

Author(s)

Robin K. S. Hankin <r.hankin@noc.soton.ac.uk>

Examples

```
googol <- as.brob(1e100)
googolplex <- 10^googol

f <- function(n){exp(n)*n^n*sqrt(2*pi*n)}

f(googol) # close to factorial(googol)
```

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

Coerces to numeric or complex form

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.

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 (!)
```

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
```

`cbrob`*Combine Brobdingnagian vectors*

Description

Combine Brobdingnagian or Glubdubbdrubian vectors through concatenation

Usage

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

Arguments

| | |
|------------------|--------------------------------------|
| <code>x</code> | Brobdingnagian vector |
| <code>...</code> | 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.

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

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

| | |
|--------------------|--|
| <code>x</code> | Object of class <code>brob</code> or <code>glub</code> |
| <code>i</code> | elements to extract or replace |
| <code>value</code> | 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 | Brobbingnagian object |
| value | In function sign<-(), Boolean specifying whehter 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>Glubbudribian numbers: complex numbers with Brobdingnagian real and imaginary parts</i> |
|------|--|

Description

Create, coerce to or test for a Glubbudribian 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 Glubbudribian form |

Details

Function `glub()` takes two arguments that are coerced to Brobdingnagian numbers and returns a complex 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 Glubbudribian form.

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

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 colloquial R idiom
```

| | |
|----------------|---------------------------------------|
| length-methods | <i>Get lengths of brobs and glubs</i> |
|----------------|---------------------------------------|

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

| | |
|-------------------|--|
| <code>x</code> | Object of class brob (or sometimes glub) |
| <code>base</code> | In function <code>log()</code> , 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

| | |
|-----|------------------------------------|
| x,y | Brob or glub |
| ... | Further arguments passed to plot() |

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

`x` An object of class brob or glub
`...` 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

`x, ...` Objects of class brob or, in the case of `sum()` and `prob()`, class glub
`na.rm` 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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