

Package ‘vfunc’

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Description If `f <- function(x){x^2}` and `g <- function(x){x+1}` it is a constant source of annoyance that ``f+g`` is not defined. Package ‘vfunc’ allows you to do this, and we have `(f+g)(2)` returning 5. The other arithmetic operators are similarly implemented. A wide class of coding bugs is eliminated.

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Description

If `f <- function(x){x^2}` and `g <- function(x){x+1}` it is a constant source of annoyance to me that “f+g” is not defined. Package vfunc allows you to do this.

Details

The package defines a single S4 class, `vf`. This has a single slot, `.Data`, of type `function` which means that `vf` objects inherit much of the behaviour of functions, but for which new methods (such as the `Arith` group of S4 generics) may be defined.

Documentation Index

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vfunc-package	Manipulate Virtual Functions

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Examples

```
f <- as.vf(function(x){x^2})
```

```
f + Sin
```

```
as.function(f*Sin + Exp)(1:4)
```

`as.vf`*Coerce functions to a virtual function.*

Description

Coerce objects to a virtual function. Numeric or complex arguments are coerced to a constant function.

Usage`as.vf(x)`**Arguments**

`x` Generally, a function or numeric

Value

Returns an object of class `vf`.

Note

It is rarely necessary to coerce objects such as vectors or matrices to class `vf` because the `Arith` methods operate on objects of class `ANY` directly.

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Examples

```
as.vf(\(x)x^2)
Sin + as.vf(\(p){p^3})
```

```
as.vf(1:10)(1e99)
```

 Compare-methods

 Compare *methods for vf objects*

Description

Wouldn't it be nice to say $(f > g)(x)$ rather than the terrible, tedious and error-prone $f(x) > g(x)$? Well, now you can!

Methods

```
signature(e1 = "ANY", e2 = "vf")
signature(e1 = "function", e2 = "vf")
signature(e1 = "vf", e2 = "ANY")
signature(e1 = "vf", e2 = "function")
signature(e1 = "vf", e2 = "vf")
```

Examples

```
x <- seq(from=0, to=2*pi, len=100)
(Sin > Cos*Tan)(x)
```

 Math

*Math group generic functions in the **vfunc** package: trig, exponential, log, etc.*

Description

The S4 Math group contains 35 functions including `sin()`, `log()`, etc. The `vfunc` equivalents are capitalized, as in `Sin()`, `Log()`, etc.

Usage

```
Abs(x)
Sign(x)
Sqrt(x)
Ceiling(x)
Floor(x)
Trunc(x)
Cummax(x)
Cummin(x)
Cumprod(x)
Cumsum(x)
Log(x)
Log10(x)
```

Log2(x)
 Log1p(x)
 Acos(x)
 Acosh(x)
 Asin(x)
 Asinh(x)
 Atan(x)
 Atanh(x)
 Exp(x)
 Expn1(x)
 Cos(x)
 Cosh(x)
 Cosp(x)
 Sin(x)
 Sinh(x)
 Sinpi(x)
 Tan(x)
 Tanh(x)
 Tanpi(x)
 Gamma(x)
 Lgamma(x)
 Digamma(x)
 Trigamma(x)

Arguments

`x` Generally take a single argument of class `numeric`, `function`, or `vf`

Details

The reason for this rather untransparent device is that primitive functions such as `sin()` behave somewhat differently from other functions. We have:

```
Sin <- as.vf(function(x){sin(x)})
setMethod("sin", "vf", function(x){as.vf(function(o){Sin(x(o))})})
```

We define `Sin()` to be an object of class `vf`; the call to `setMethod()` ensures that `Sin(f)` operates as intended.

Value

Given a `numeric`, return a `numeric`; given a `vf`, return a `vf`

Note

Note that “`sin <- as.vf(sin)`” does not work as desired, giving a runtime error; trying to get round this with things like “`sin <- as.vf(function(x)sin)`” and similar means that “`sin(3)`” does not work.

There is no way to inform all `vf` objects that, if used as a function with an argument of a primitive such as `sin`, to return another `vf` object—and not to try and evaluate “`f(sin)`”, which fails:

```
f <- as.vf(function(x){x^2 + 1})
f(Sin)
#> An object of class "vf"
#> function (...)
#> {
#>   e1(...) + e2
#> }
#> <bytecode: 0x6065e7c8a900>
#> <environment: 0x6065e7c8a548>
f(sin)
#> Error in x^2: non-numeric argument to binary operator
```

Above, we see `f(sin)` returning an error (it tries to evaluate “`sin^2 + 1`”). Observe that “`Sin^2 + 1`” is perfectly OK, for `Sin` is a virtual function.

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Examples

`Sin + Exp`

```
c((Sin + Exp)(.02232) ,sin(0.02232) + exp(0.02232))
```

Math-methods

Methods for Function Math, Arith in the vfunc package

Description

Various S4 methods to work with vf objects. Comparison methods are documented at `Compare-methods`.

pow

Iterated functions; functional powers

Description

Given a function $f: X \rightarrow X$, we define

$$f^0 = \text{id}_X$$

$$f^{n+1} = f \circ f^n = f^n \circ f, \quad n \geq 0$$

This gives us $f^{n+m} = f^n \circ f^m$ and $(f^m)^n = f^{mn}$, which motivates the notation. For example, $\sin^3 = \sin \circ \sin \circ \sin$, so $\sin^3(x) = \sin(\sin(\sin x))$.

The operator is well-defined due to the power associativity of function composition.

Usage

```
pow(x, n)
```

Arguments

x	Object of class vf
n	Non-negative integer

Value

Returns an object of class vf

Note

There are possibly more efficient methods requiring fewer compositions, e.g. `pow(f, 9)` (which would require 8 function compositions) could be evaluated by `pow(pow(f, 3), 3)` (which requires only four). But I am not sure that this would actually be any faster, and I have not got round to thinking about it yet.

Also, package idiom for the caret “^” is reserved for arithmetic exponentiation [so, for example, $(f^3)(x) == f(x)*f(x)*f(x)$]. I believe this is sub-optimal but was unable to overload the caret to implement functional iteration.

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Examples

```
pow(Sin, 5)
Sin^5

f <- as.vf(function(x){x^2+1})

pow(f + Sin, 4)
pow(f + Sin, 4)(2)
```

 vf-class

 Class "vf"

Description

Class vf stands for “virtual function”

Objects from the Class

Objects can be created by calls of the form `new("vf", ...)`.

Slots

.Data: Object of class "function"

Methods

Arith signature(e1 = "function", e2 = "vf"): ...
Arith signature(e1 = "ANY", e2 = "vf"): ...
Arith signature(e1 = "vf", e2 = "function"): ...
Arith signature(e1 = "vf", e2 = "missing"): ...
Arith signature(e1 = "vf", e2 = "ANY"): ...
Arith signature(e1 = "vf", e2 = "vf"): ...
as.function signature(x = "vf"): ...
as.vf signature(x = "vf"): ...
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coerce signature(from = "ANY", to = "vf"): ...
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Compare signature(e1 = "vf", e2 = "function"): ...
Compare signature(e1 = "vf", e2 = "ANY"): ...
Compare signature(e1 = "vf", e2 = "vf"): ...
Math signature(x = "vf"): ...

Author(s)

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Examples

```
showClass("vf")
```

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