

# Package ‘Ryacas’

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**Version** 1.1.5

**Title** R Interface to the 'Yacas' Computer Algebra System

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**Encoding** UTF-8

**Description** Interface to the 'yacas' computer algebra system (<<http://www.yacas.org/>>).

**Depends** R (>= 3.3.0)

**Imports** Rcpp (>= 0.12.0), stats, methods, magrittr

**LinkingTo** Rcpp

**Suggests** devtools, exams, knitr, Matrix, pkgload, rmarkdown, igraph, testthat (>= 2.1.0), unix, Rmpfr

**License** GPL

**SystemRequirements** C++14

**URL** <https://github.com/r-cas/ryacas>, <http://www.yacas.org>

**BugReports** <https://github.com/r-cas/ryacas/issues>

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**NeedsCompilation** yes

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Ryacas-package	<i>R interface to yacas computer algebra package</i>
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**Description**

Ryacas allows one to use the yacas computer algebra package entirely from within R.

**Details**

Please read the "Getting started" vignette.

---

as.character.yac_symbol	<i>Convert yac symbol to character</i>
-------------------------	--

---

**Description**

Convert yac symbol to character

**Usage**

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

**Arguments**

x	A yac_symbol
...	not used

---

as_r	<i>Convert yacas object to R</i>
------	----------------------------------

---

**Description**

If x is a yacas command as string, convert to a character vector/matrix in R. If x is a yac\_symbol (e.g. from `ysym()`), then convert it to a numeric object if there are no variables or a character type if there are variables.

**Usage**

```
as_r(x)
```

**Arguments**

x                    yacas list or list of lists to convert

**Details**

In yacas a vector is a list, and a matrix is a list of lists.

---

as_y	<i>Convert R vector/matrix to yacas vector (list) or matrix (list of lists)</i>
------	---

---

**Description**

Convert R vector/matrix to yacas vector (list) or matrix (list of lists)

**Usage**

```
as_y(x)
```

**Arguments**

x                    R vector to convert

---

cbind.yac_symbol	<i>Combine R Objects by Columns</i>
------------------	-------------------------------------

---

**Description**

Combine R Objects by Columns

**Usage**

```
## S3 method for class 'yac_symbol'
cbind(..., deparse.level = 1)
```

**Arguments**

...                    Objects to bind  
deparse.level    Not used

---

deriv.yac_symbol	<i>Find the derivative of yac symbol</i>
------------------	--

---

**Description**

Find the derivative of yac symbol

**Usage**

```
## S3 method for class 'yac_symbol'  
deriv(expr, ...)
```

**Arguments**

expr	A yac_symbol
...	variables as character vector to take derivate with respect to

---

det	<i>Matrix Determinant</i>
-----	---------------------------

---

**Description**

From [base::det\(\)](#).

**Usage**

```
det(x, ...)
```

**Arguments**

x	If yac_symbol treat as such, else call <a href="#">base::det()</a> .
...	further arguments passed to <a href="#">base::det()</a>

**Examples**

```
(x <- matrix(1:4, ncol = 2))  
det(x)  
det(ysym(x))
```

---

diag *Matrix diagonals*

---

**Description**

From `base::diag()`.

**Usage**

```
diag(x, ...)
```

**Arguments**

x                    If `yac_symbol` treat as such, else call `base::diag()`.  
 ...                  further arguments passed to `base::diag()`

---

diag<- *Matrix diagonals*

---

**Description**

From `base::diag()`.

**Usage**

```
diag(x) <- value
```

**Arguments**

x                    If `yac_symbol` treat as such, else call `base::diag<-()`.  
 value                New value for `diag(x)`

---

Hessian *Find the Hessian matrix of yac symbol*

---

**Description**

Find the Hessian matrix of `yac` symbol

**Usage**

```
Hessian(expr, ...)
```

**Arguments**

expr                A `yac_symbol`  
 ...                variables as character vector to take Hessian with respect to

---

integrate

*Integration of Functions*

---

### Description

If `f` is a `yac_symbol`, `yacas`'s `Integrate()` is used. Else, `stats::integrate()` is used.

### Usage

```
integrate(f, ...)
```

### Arguments

<code>f</code>	Function to integrate. See details.
<code>...</code>	See details.

### Details

Additional arguments:

- `yac_symbol`: `var`, `lower`, `upper`
- Else (`stats::integrate()`): `lower`, `upper`

---

Jacobian

*Find the Jacobian matrix of yac symbol*

---

### Description

Find the Jacobian matrix of `yac` symbol

### Usage

```
Jacobian(expr, ...)
```

### Arguments

<code>expr</code>	A <code>yac_symbol</code>
<code>...</code>	variables as character vector to take Jacobian with respect to

---

lim	<i>Limits</i>
-----	---------------

---

**Description**

If first argument is a `yac_symbol`, `yacas's Limit()` is used.

**Usage**

```
lim(...)
```

**Arguments**

... See details.

**Details**

Arguments:

- `yac_symbol`: `f`, `var`, `val`, `from_left`, `from_right`

---

lower.tri	<i>Lower and upper triangular part of a matrix</i>
-----------	--

---

**Description**

Lower and upper triangular part of a matrix

**Usage**

```
lower.tri(x, diag = FALSE)
```

**Arguments**

`x` If `yac_symbol` treat as such, else call `base::lower.tri()/base::upper.tri()`.  
`diag` Whether diagonal is included.



---

Math.yac\_symbol      *Math functions*

---

**Description**

Math functions

**Usage**

```
## S3 method for class 'yac_symbol'  
Math(x, ...)
```

**Arguments**

x                    yac\_symbol.  
...                  further arguments passed to methods

---

Ops.yac\_symbol      *Math operators*

---

**Description**

Math operators

**Usage**

```
## S3 method for class 'yac_symbol'  
Ops(e1, e2)
```

**Arguments**

e1                    A yac\_symbol.  
e2                    A yac\_symbol.

---

pow *Matrix Power*

---

### Description

Matrix Power

### Usage

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

```
## Default S3 method:
```

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

### Arguments

x	If <code>yac_symbol</code> treat as such, else call <code>pow.default()</code> .
n	nth power of the square matrix.
...	further arguments passed to <code>pow.default()</code>

### Examples

```
(x <- matrix(c(1, 2, 2, 3), ncol = 2))
pow(x, 2)
pow(ysym(x), 2)
```

---

prod.yac\_symbol *Product of Vector Elements*

---

### Description

Product of Vector Elements

### Usage

```
## S3 method for class 'yac_symbol'
prod(expr, ..., na.rm = FALSE)
```

### Arguments

expr	Expression to be multiplied
...	Not used
na.rm	Not used

---

rbind.yac_symbol	<i>Combine R Objects by Rows</i>
------------------	----------------------------------

---

**Description**

Combine R Objects by Rows

**Usage**

```
## S3 method for class 'yac_symbol'  
rbind(..., deparse.level = 1)
```

**Arguments**

...	Objects to bind
deparse.level	Not used

---

simplify	<i>Simplify expression</i>
----------	----------------------------

---

**Description**

Simplify expression

**Usage**

```
simplify(x, timeout = 2)
```

**Arguments**

x	A yac_symbol
timeout	timeout in seconds before simplification is aborted; only works when package unix is available

---

solve.yac\_symbol      *Solve a system of equations*

---

### Description

This generic function solves the equation  $ax = b$  for  $x$ .

### Usage

```
## S3 method for class 'yac_symbol'
solve(a, b, ...)
```

### Arguments

a	A yac_symbol
b	A yac_symbol or a value, see details and examples.
...	See details and examples.

### Details

When a is a matrix and b not provided, this finds the inverse of a. When a is a matrix and a vector b is provided, the linear system of equations is solved.

Note that solving non-linear equations:

- solve(a, b): find roots of a for variable b, i.e. yacas Solve(a == 0, b)
- solve(a, b, v): find solutions to a == b for variable v, i.e. yacas Solve(a == b, v)

This also works for a system of equations (when a is a vector)

### Examples

```
A <- outer(0:3, 1:4, "-") + diag(2:5)
a <- 1:4
B <- ysym(A)
b <- ysym(a)
solve(A)
solve(B)
solve(A, a)
solve(B, b)

poly <- ysym("x^2 - x - 6")
solve(poly, "x") # Solve(poly == 0, x)
solve(poly, 3, "x") # Solve(poly == 3, x)
```

---

sum.yac_symbol	<i>Summation</i>
----------------	------------------

---

**Description**

If only expr given: sum elements.

**Usage**

```
## S3 method for class 'yac_symbol'
sum(expr, var, lower, upper, ..., na.rm = FALSE)
```

**Arguments**

expr	Expression to be summed
var	Variable to sum
lower	Lower limit
upper	Upper limit
...	Not used
na.rm	Not used

**Details**

Else: sums expr by letting var taking values from lower to upper (potentially Inf)

---

t	<i>t</i>
---	----------

---

**Description**

t

**Usage**

```
## S3 method for class 'yac_symbol'
t(x)
```

**Arguments**

x	If yac_symbol treat as such, else call <code>base::t()</code> .
---	---

---

tex	<i>Export object to TeX</i>
-----	-----------------------------

---

**Description**

Export object to TeX

**Usage**

```
tex(x)
```

**Arguments**

x	A yac_symbol
---	--------------

---

tr	<i>Matrix Trace</i>
----	---------------------

---

**Description**

The trace of a square matrix is the sum of the diagonal elements.

**Usage**

```
tr(x, ...)
```

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

**Arguments**

x	If yac_symbol treat as such, else call <code>tr.default()</code> .
...	further arguments passed to <code>tr.default()</code>

**Examples**

```
(x <- matrix(1:4, ncol = 2))  
tr(x)  
tr(ysym(x))
```

---

upper.tri	<i>Lower and upper triangular part of a matrix</i>
-----------	--

---

**Description**

Lower and upper triangular part of a matrix

**Usage**

```
upper.tri(x, diag = FALSE)
```

**Arguments**

x	If <code>yac_symbol</code> treat as such, else call <code>base::lower.tri()/base::upper.tri()</code> .
diag	Whether diagonal is included.

---

vec	<i>Vectorize</i>
-----	------------------

---

**Description**

Vectorize

**Usage**

```
vec(x, ...)
```

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

**Arguments**

x	If <code>yac_symbol</code> treat as such, else call <code>base::as.vector()</code> .
...	further arguments passed to <code>base::as.vector()</code>

**Examples**

```
(x <- matrix(1:9, ncol = 3))
vec(x)
vec(ysym(x))
```

---

vech	<i>Half-Vectorize</i>
------	-----------------------

---

**Description**

Half-Vectorize

**Usage**

```
vech(x, ...)
```

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

**Arguments**

x	If <code>yac_symbol</code> treat as such, else call <code>vech.default()</code> .
...	further arguments passed to <code>vech.default()</code>

**Examples**

```
A <- mtcars[, c(1, 3, 4, 5, 6, 7)]
x <- cov(A)
vech(x)
vech(ysym(x))
```

---

with_value	<i>Give a variable a value</i>
------------	--------------------------------

---

**Description**

Give a variable a value

**Usage**

```
with_value(x, var, val)
```

**Arguments**

x	<code>yac_symbol</code>
var	Variable
val	Value



---

yac *Run yacas command*

---

**Description**

Run yacas command

**Usage**

```
yac(x, rettype = c("str", "expr", "silent"))
```

**Arguments**

x	yacas command
rettype	str for string/character, expr for expression, silent for silent

**Examples**

```
yac("D(x) x^2 + 4*x")  
yac("D(x) x^2 + 4*x", rettype = "str")  
yac("D(x) x^2 + 4*x", rettype = "expr")  
yac("D(x) x^2 + 4*x", rettype = "silent")
```

---

yac\_assign *Assign yacas variable*

---

**Description**

Assign yacas variable

**Usage**

```
yac_assign(value, x)
```

**Arguments**

value	Expression
x	Variable name

---

`yac_cli`*yacas command line interface*

---

**Description**

Interactive interface to the yacas

**Usage**

```
yac_cli(enable_history = TRUE)
```

**Arguments**

`enable_history` Use R history such that previous yacas commands can be used. Default is TRUE.

**Details**

The user types valid yacas input and presses return. Type 'quit' to return to R prompt.

**Value**

Output of yacas is returned.

**Note**

Note that command will use R `history()` and modify it by default. Yacas is given a limited amount of time to complete, otherwise `\[1\]` `CommandLine(1)` : User interrupted calculation is returned. E.g. `Taylor(x,0,5) 1/(1+x)` will work, but `Taylor(x,0,12) 1/(1+x)` is likely to take too long.

**References**

<https://yacas.sourceforge.io/>

**Examples**

```
## Not run:
yac_cli()
(x+y)^3-(x-y)^3
Simplify(%)
q
## End(Not run)
```

---

`yac_expr`*Run yacas command returning R expression*

---

**Description**

Run yacas command returning R expression

**Usage**

```
yac_expr(x)
```

**Arguments**

x                    yacas command

**Examples**

```
yac_expr("D(x) x^2 + 4*x")
yac_expr("Limit(x, 1) (x^2 - 1)/(x - 1)")
yac_expr("Sum(n, 1, Infinity, (1/2)^n)")
yac_expr("Fibonacci(10)")
yac_expr("Sum(n, 1, 10, Fibonacci(n))")
```

---

`yac_silent`*Run yacas command silently*

---

**Description**

Run yacas command silently

**Usage**

```
yac_silent(x)
```

**Arguments**

x                    yacas command

yac\_str

*Run yacas command returning string/character*

---

**Description**

Run yacas command returning string/character

**Usage**

```
yac_str(x)
```

**Arguments**

x                    yacas command

**Examples**

```
yac_str("D(x) x^2 + 4*x")
yac_str("Limit(x, 1) (x^2 - 1)/(x - 1)")
yac_str("Sum(n, 1, Infinity, (1/2)^n)")
yac_str("Fibonacci(10)")
yac_str("Sum(n, 1, 10, Fibonacci(n))")
yac_str("TeXForm(x^2 - 1)")
```

---

yac\_symbol*Make a yacas symbol*

---

**Description**

This is an alias for [ysym\(\)](#). See description there.

**Usage**

```
yac_symbol(x)
```

**Arguments**

x                    A vector or a matrix

**Value**

A yac\_symbol

---

ysym	<i>Make a yacas symbol</i>
------	----------------------------

---

**Description**

Note that this results in multiple calls to `yacas` and the performance may be slower than manually using e.g. `yac_str()`.

**Usage**

```
ysym(x)
```

**Arguments**

x                    A vector or a matrix

**Value**

A `yac_symbol`

---

ysym_ls	<i>List defined yac_symbols</i>
---------	---------------------------------

---

**Description**

List defined `yac_symbols`

**Usage**

```
ysym_ls(print_details = FALSE)
```

**Arguments**

print\_details    print content of symbols

---

y\_eval                      *Evaluate a yacas expression*

---

### Description

Evaluate a yacas expression by replacing variables with values as for the given list.

### Usage

```
y_eval(expr, ..., as.r = FALSE)
```

### Arguments

expr	a valid yacas expression
...	a list of assignments (see example)
as.r	if TRUE, then the expression is evaluated as R (if any variable to be substituted in the expression is a vector, then a vector is returned). If it is FALSE (default), a yacc expression is returned, replacing scalar variables.

### Examples

```
# Evaluate as yacas object
eq <- ysym("2*y+x^2+2*x-3")
y_eval(eq, x=3, y=2)

# Evaluate as R expression:
y_eval(eq, x=3, y=2, as.r=TRUE)
# This allows to use vectors:
y_eval(eq, x=1:10, y=2, as.r=TRUE)
# and to plot functions:
curve(y_eval(eq, x=x, y=2, as.r=TRUE), xlim=c(0,10))
```

---

y\_fn                              *Prepare simple yacas call*

---

### Description

Prepare simple yacas call

### Usage

```
y_fn(x, fn, ...)
```

**Arguments**

x	parameter to function fn
fn	function with parameter x
...	additional arguments to fn

**Examples**

```

y_fn("x^2 - 1", "TeXForm")
yac_str(y_fn("x^2 - 1", "TeXForm"))

y_fn("x^2 - 1", "Factor")
yac_str(y_fn("x^2 - 1", "Factor"))

cmd <- "x^2 - 1 == 0" %>% y_fn("Solve", "x")
cmd
sol <- yac_str(cmd)
sol
yac_str(y_rmvars(sol))

```

y\_print

*Pretty print yacas strings***Description**

Pretty print yacas strings

**Usage**

```
y_print(x)
```

**Arguments**

x	yacas string, e.g. a matrix
---	-----------------------------

**Examples**

```

A <- diag(4)
Ayac <- as_y(A)
y_print(Ayac)

B <- A
B[2, 2] <- "-t"
Byac <- as_y(B)
Byac
y_print(Byac)

```

---

`y_rmvars`*Remove/strip variable names*

---

**Description**

This only builds a yacas command. You need to also call `yac_str()`, `yac_expr()` or similar. This is the reason that it does not call yacas: it depends on how you want it returned (string, expression).

**Usage**

```
y_rmvars(x)
```

**Arguments**

`x`                    yacas command

**Examples**

```
cmd <- "{x == 2, y == 4}"
yac_str(cmd)
yac_str(y_rmvars(cmd))
```

---

`[.yac_symbol`*Extract or replace parts of an object*

---

**Description**

Extract or replace parts of an object

**Usage**

```
## S3 method for class 'yac_symbol'
x[i, j]
```

**Arguments**

`x`                    A yac\_symbol.  
`i`                    row indices specifying elements to extract or replace  
`j`                    column indices specifying elements to extract or replace



---

[<-.yac\_symbol            *Extract or replace parts of an object*

---

**Description**

Extract or replace parts of an object

**Usage**

```
## S3 replacement method for class 'yac_symbol'  
x[i, j] <- value
```

**Arguments**

x	A yac_symbol.
i	row indices specifying elements to extract or replace
j	column indices specifying elements to extract or replace
value	the value to replace x[i, j] by

---

[].yac\_symbol            *Extract parts of an object*

---

**Description**

Extract parts of an object

**Usage**

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

**Arguments**

x	A yac_symbol.
i	indices specifying elements to extract

---

%\*%

*Matrix multiplication*

---

**Description**

Matrix multiplication

**Usage**

x %\*% y

**Arguments**

x            A yac\_symbol

y            A yac\_symbol

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