A quick guide to caracas

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What is caracas?

caracas is an R package that gives symbolic mathematics in R. caracas is based on SymPy (a computer algebra system for Python).
Function names are kept the same as in R if the function does the same, but have been given a postfix _ if the functionality is different (e.g. sum_()).

Creating symbols

```
k <- symbol("k")                    k
def_sym(a, b)                       a
                                    b
def_sym_vec(c("a", "b"))            a
                                    b
v <- vector_sym(2, "v")             [[v1, v2]]^T
M <- matrix_sym(2, 2, "m")          [[m11, m12],
                                     [m21, m22]]
D <- matrix_sym_diag(2)             [[v1, 0],
                                     [ 0, v2]]
```

Coerce R objects to symbols

```
T2 <- matrix(c("a", "b", "b", "a"), nrow = 2)
T3 <- toeplitz(c("a", "b", "0"))
T2 <- as_sym(T2)                    [[a, b],
                                     [b, a]]
T3 <- as_sym(T3)                    [[a, b, 0],
                                     [b, a, b],
                                     [0, b, a]]
```

Standard R functions

```
c(v, v)                             output omitted
cbind(v)                            output omitted
rbind(v)                            output omitted
sum(v)                              v1 + v2
cumsum(v)                           [[v1, v1 + v2]]^T
rep(v, times = 2)                   output omitted
rep(v, each = 2)                    output omitted
rev(v)                              [[v2, v1]]^T
```

Algebra

```
simplify(cos(a)^2 + sin(a)^2)       1
solve_sys(a^2, -1, a)               a = -1i
                                    a = 1i
inv(T2)                             output omitted
solve(T2)                           output omitted
factor_(a^3 - a^2 + a - 1)          (a - 1)*(a^2 + 1)
expand((a - 1) * (a^2 + 1))         a^3 - a^2 + a - 1
```

Calculus

```
der(3 * a + a^2, a)                 2*a + 3
sum_(1/a^2, a, 1, Inf)              pi^2/6
s <- sum_(1/a^2, a, 1, Inf, doit = FALSE)
s                                   ∑_{a=1}^{∞} 1/a^2
doit(s)                             pi^2/6
lim((1 + a)^(1/a), a, 0)            exp(1)
f <- taylor(cos(a), x0 = 0, n = 3 + 1)
drop_remainder(f)                   1 - a^2/2
```

Subsetting

```
T3[1:2, 2:3]                        [[b, 0],
                                     [a, b]]
T3[1:2]                             [[a, b]]^T
T3[2]                               b
T3[2, ]                             [[b, a, b]]^T
```

Linear algebra

```
rankMatrix_(T2)                     2
rref(T2)                            $mat
                                    [[1, 0],
                                     [0, 1]]
                                    $pivot_vars
                                    [1] 1 2
T2i <- solve(T2)
scale_matrix(T2i, det(T2i))         1/(a^2 - b^2)*[
                                    [ a, -b],
                                    [-b, a]]
QRdecomposition(D)                  output omitted
LUdecomposition(D)                  output omitted
chol(D, hermitian = FALSE)          output omitted
svd_(D)                             output omitted
```

Substitution and evaluation

```
subs(T2, "b", "b-k")                [[ a, b - k],
                                     [b - k, a]]
subs(T2, c("a", "b"), c(1, 2))      [[1, 2],
                                     [2, 1]]
```

Coercion to R objects

```
T2e <- as.expression(T2) # or as_expr()
T2e
```

```
## expression(matrix(c(a, b, b, a), nrow = 2))
```

```
T2f <- as.function(T2) # or as_func()
```

```
eval(T2e, list(a = 1, b = 2))       output omitted
T2f(a = 1, b = 2)                   output omitted
T2f2 <- as.function(T2, vec_arg = TRUE)
T2f2(c(a = 1, b = 2))               output omitted
```

Extending caracas

SymPy documentation at https://docs.sympy.org/.
With helper function sympy_func():

```
sympy_func(T2, "inverse_BLOCK")     output omitted
sympy_func(T2, "upper_triangular")  output omitted
```

Calling SymPy directly via reticulate:

```
get_sympy()$diff("2*a*x**2", "x") |> as.character()
```

```
## [1] "4*a*x"
```

Output

Functions: tex(), print(..., method = "prettyascii") and others.
Chunk type rtex for e.g. rmarkdown/Quarto.

Bridging a gap
caracas
SYMBOLIC MATH IN R

Online docs
https://r-cas.github.io/caracas/

Updated Nov 2023
caracas v. 2.1.1