Mathfuns User's Manual

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1 Introduction

Mathfuns is a completely new scientific computing platform, which support edit and compute in the way of mathematical formula. It makes you focus on mathematical problem itself, and make complex mathematical calculations simply beyond imagination. It's a platform for everyone, which is designed to make you have different funs in solving problems and experience programming with it.

2 Formula editor

2.1 Support for all kinds of input

Digit, punctuation, english letter, greek letter, mathematical operation symbols.

2.2 Powerful formula editing ability

Support the vast majority of formula editing and computing. You can see the details in the following calculation modules.

3 Calculation modules

3.1 Base arithmetic operations

+, -, *, /, ()

3.2 Common functions

Logarithm: $\ln$, $\log_2$, $\log_{10}$

Sqrt: $\sqrt{\ }$

root: $\sqrt[y]{x}$

pow: x^y

Example:

$$1+\frac{3}{5}*\log_2(8)$$

$>>> 2.8$

Example:

$x=2$

$y=\sqrt{x+1}$

$>>> y=1.73205080756888$

3.3 Common mathematical constants

Natural number: e

2.71828182845905

PI: π

3.14159265358979

Infinity: ∞

Euler-Mascheroni constant: γ

0.577215664901533

Catalan's constant: G

0.915965594177219

Golden ratio: φ

1.61803398874989

3.4 complex number

3.4.1 i

Example:

i^2

$>>> -1$

ImaginaryUnit

3.4.2 Re

Example:

$$\mathrm{Re}(1+2*i)$$
$$>>1$$

Returns real part of expression.

3.4.3 Im

Example:

$$\mathrm{Re}(1+2*i)$$
$$>>2$$

Returns imaginary part of expression

3.4.4 $|z|$

Example:

$$|1+2*i|$$
$$>>2.23606797749979$$

Return the absolute value of the argument

3.4.5 $\overline{z}$

Example:

$$\overline{1+2*i}$$
$$>>1-2*i$$

The complex conjugate of a complex number is given by changing the sign of the imaginary part

3.5 Trigonometric function and inverse trigonometric function

sin, cos, tan, cot, sec, csc

$\sin^{-1}, \cos^{-1}, \tan^{-1}, \cot^{-1}, \sec^{-1}, \csc^{-1}$

Example:

$$\sin(\pi/6)$$
$$>>>0.5$$

Example:

$$y = \sin^{-1}(0.5) * 6$$
$$>>> y = 3.14159265358979$$

3.6 Hyperbolic function and inverse hyperbolic function

Sinh, cosh, tanh, coth, sech, csch

$\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, $\coth^{-1}$, sech^{-1}, csch^{-1}

Example:

$$y = \sinh(3)$$
$$>>> y = 10.0178749274099$$

Example:

$$y = \sinh^{-1}(10.0178749274099)$$
$$>>> y = 3$$

3.7 Sum

Example

$$y = \sum_{x=1}^{3} 2 * x$$
$$>>> y = 12$$

Sum represents a finite or infinite series with four arguments. The first parameter is in the lower left side of Σ, as x in the above example, which is a symbol variable. The second parameter is in the lower right side of Σ, as 1 in the above example, which is the start value of the first parameter. The third parameter is on the top of Σ, as 3 in the above example, which is the end value of the first parameter. The last parameter is the general form of terms in the series, as $2 * x$ in the above example.

3.8 Product

Example:

$$y = \prod_{x=1}^{3} 2 * x$$
$$>>> y = 48$$

Product represents a finite or infinite product with four arguments. The first parameter is in the lower left side of Π, as x in the above example, which is a symbol variable. The second parameter is in the lower right side of Π, as 1 in the above example, which is the start value of the first parameter. The third parameter is on the top of Π, as 3 in the above example, which is the end value of the first parameter. The last parameter is the general form of terms in the series, as $2*x$ in the above example.

3.9 Polynomials Manipulation

3.9.1 Simplify

Example:

$$simplify\left(\left(x^3+x^2-x-1\right)/\left(x^2+2*x+1\right)\right)$$

$$>>> x-1$$

Simplify the given expression.

3.9.2 Collect

Example:

$$collect(x*y+x-3+2*x^2-z*x^2+x^3,x)$$

$$>>> x^3+x^2*(-z+2)+x*(y+1)-3$$

Collect common powers of a term in the given expression with two parameters. The first parameter is a expression, and the second is symbol variable in the expression.

3.9.3 Expand

Example:

$$\exp and((x+1)^2)$$

$$>>> x^2+2*x+1$$

Expand the given polynomial expression.

3.9.4 Factor

Example:

$$factor(x^3-x^2+x-1)$$

$$>>> (x-1)*(x^2+1)$$

Factor the given expression into irreducible factors over the rational numbers.

3.9.5 Ratsimp

Example:

$$ratsimp(\frac{1}{x}+\frac{1}{y})$$

$$>>> \frac{x+y}{x*y}$$

Ratsimp puts an expression over a common denominator, cancel and reduce.

3.9.6 Least common multiple(lcm)

Example:

$$lcm(x*y^2+x^2*y, x^2*y^2)$$

$$>>> x^3*y^2+x^2*y^3$$

Least common multiple of the two given arguments.

3.9.7 Greatest common divisor(gcd)

Example:

$$\mathrm{gcd}(x*y^2+x^2*y, x^2*y^2)$$

$$>>> x*y$$

Greatest common divisor of the two given arguments.

3.9.8 Substituion(Subs)

Example:

$$subs(x+5, x, 1)$$

$$>>> 6$$

Subs has three prameters.

1. expression
2. symbol variable
3. value

Subs function calculation expression while the symbol variable is replaced with the given value.

3.10 Matrix

3.10.1 Create

Example:

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix} * 6$$

$$>>> \begin{pmatrix} 6 & 0 & 0 \\ 0 & 12 & 0 \\ 0 & 0 & 18 \end{pmatrix}$$

3.10.2 Diagonalize

Example:

$$A = \begin{pmatrix} 1 & 2 & 0 \\ 0 & 3 & 0 \\ 2 & -4 & 2 \end{pmatrix}$$

$$P, D = Diag(A)$$

$$>>> P = \begin{pmatrix} -1 & 0 & -1 \\ 0 & 0 & -1 \\ 2 & 1 & 2 \end{pmatrix}$$

$$>>> D = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}$$

3.10.3 LUdecomposition

Example:

$$A = \begin{pmatrix} 4 & 3 \\ 1.5 & 1 \end{pmatrix}$$

$$L, U = LU(A)$$

$$>>> L = \begin{pmatrix} 1 & 0 \\ 0.375 & 1 \end{pmatrix}$$

$$>>> U = \begin{pmatrix} 4 & 3 \\ 0 & -0.125 \end{pmatrix}$$

3.10.4 QRdecomposition

Example:

$$A = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 3 \\ 2 & 3 & 4 \end{pmatrix}$$

$$Q, R = QR(A)$$

$$>>> Q = \begin{pmatrix} 0.408248290463863 & -0.577350269189626 & -0.707106781186548 \\ 0.408248290463863 & -0.577350269189626 & 0.707106781186548 \\ 0.816496580927726 & 0.577350269189626 & 0 \end{pmatrix}$$

$$>>> R = \begin{pmatrix} 2.44948974278318 & 3.2659863237109 & 4.89897948556636 \\ 0 & 0.577350269189626 & 0 \\ 0 & 0 & 1.4142135623731 \end{pmatrix}$$

3.10.5 Rank

Example:

$$A = \begin{pmatrix} 1 & 2 \\ 3 & 5 \end{pmatrix}$$

$$R(A)$$

$$>>> 2$$

3.10.6 Dot product

Example:

$$v1 = [1 \quad 2 \quad 3]$$

$$v2 = [4 \quad 5 \quad 6]$$

$$dot(v1, v2)$$

$$>>> 32$$

3.10.7 Cross product

Example:

$$v1 = [1 \quad 2 \quad 3]$$

$$v2 = [4 \quad 5 \quad 6]$$

$$cross(v1, v2)$$

$$>>> [-3 \quad 6 \quad -3]$$

3.10.8 Determinant

Example:

$$m = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

$$\det(m)$$

$$>>> 0$$

3.10.9 Adjugate

Example:

$$m = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 18 & 9 \end{pmatrix}$$

$$m^*$$

$$>>> \begin{pmatrix} -63 & 36 & -3 \\ 6 & -12 & 6 \\ 37 & -4 & -3 \end{pmatrix}$$

3.10.10 Transposition

Example:

$$m = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 18 & 9 \end{pmatrix}$$

$$m^T$$

$$>>> \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 18 \\ 3 & 6 & 9 \end{pmatrix}$$

3.10.11 Inverse

Example:

$$m = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 18 & 9 \end{pmatrix}$$

$$m^{-1}$$

$$>>> \begin{pmatrix} \text{-1.05} & 0.6 & \text{-0.05} \\ 0.1 & \text{-0.2} & 0.1 \\ 0.616666666666667 & \text{-0.0666666666666667} & \text{-0.05} \end{pmatrix}$$

3.11 Calculus

3.11.1 Taylor

Example:

$$series(\cos(x), x, 0, 5)$$

$$>>> 1 - \frac{x^2}{2} + \frac{x^4}{24} + O(x^5)$$

Taylor series has 4 parameters:

1. Function
2. **Variable of the function**
3. **A point**
4. **terms of order**

3.11.2 Gamma

Example:

$$\Gamma(1)$$

$$>>> 1$$

$$\Gamma(t) = \int_0^\infty x^{t-1} e^{-x} dx\,, \quad t > 0$$

3.11.3 Zeta

Example:

$$\zeta(2)$$

$$>>> 1.64493406684823$$

$$\zeta(s) = \lim(1 + \frac{1}{2^s} + \frac{1}{3^s} + \frac{1}{4^s} + \ldots + \frac{1}{n^s})$$

3.11.4 Limits

Example:

$$\lim_{x \to 0} \frac{\sin(x)}{x}$$

$$>>> 1$$

3.11.4.1 Right limit

Example:

$$\lim_{x \to 0^+} \frac{1}{x}$$

$$>>> \infty$$

3.11.4.2 Left limit

Example:

$$\lim_{x \to 0^-} \frac{1}{x}$$

$>>> -\infty$

3.11.5 Integral

3.11.5.1 Definite integral

Example:

$$\int_0^\infty e^{-x} dx$$

$>>> 1$

3.11.5.2 Indefinite integral

Example:

$$\int x dx$$

$>>> \frac{x^2}{2}$

3.11.5.3 Multiple integral

Repeat above operation

3.11.6 Derivatives

3.11.6.1 N-th order derivative

Example:

$$\frac{dIn(x)}{dx}$$

$>>> x^{-1}$

3.11.6.2 Partial derivative

Example:

$$\frac{d\partial y * In(x)}{d\partial x}$$

$$>>> \frac{y}{x}$$

3.12 Solving equations

3.12.1 Function Define

Func has at least one parameters. The first parameter is the name of function, other parameters is the variables of the function.

f function without parameter $func(f)$

f function with one parameter x: $\begin{matrix} \mathrm{var}(x) \\ func(f, x) \end{matrix}$

f function with two parameters x and y: $\begin{matrix} \mathrm{var}(x, y) \\ func(f, x, y) \end{matrix}$

3.12.2 Algebraic equation

$solve$ has at least two parameters.

The first parameter:

a single Expr or Poly that must be zero

an Equality

a Relational expression or Boolean

iterable of one or more of the above

The other parameters:

The symbol of variables in the first parameter

Example:

$$solve(x^2 - 1 = 0, x)$$

$$>>> [1, -1]$$

Example:

$$solve(x^2 - y^2 = 0, x)$$
$$>>> [-y, y]$$

Example:

$$solve(\begin{cases} 2*y - x = 1 \\ 4*y - x = 3 \end{cases}, x, y)$$
$$>>> \{x:1, y:1\}$$

3.12.3 Ordinary differential equation(ODE)

Example:

$$func(f, x)$$
$$ode(\frac{d^2 f}{dx^2} + 9*f, f)$$
$$>>> f(x) = C_1 * \sin(3*x) + C_2 * \cos(3*x)$$

ODE has two parameters.

1. **any supported ordinary differential equation**
2. **a function of one variable whose derivatives in that**

3.12.4 Partial differential equation(PDE)

Example:

$$func(f, x, y)$$
$$pde(1 + 2*\frac{\partial f}{\partial x} / f + 3*\frac{\partial f}{\partial y} / f)$$
$$>>> f(x, y) = F(3*x - 2*y)*e^{(-\frac{2*x}{13} - \frac{3*y}{13})}$$

PDE has one parameter. It can be **any supported partial differential equation. The function is that PDE with two symbol variables.**