Computer Programming

Part 5: Symbolic Variables

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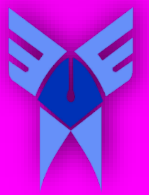
متغیرهای symbolic

تعریف

- تا کنون متغیرهای تعریف شده، ماتریس، بردار، اسکالر و رشته بودند.
- با استفاده از دستورات sym و یا syms می توان متغیرهای symbolic تولید نمود.
- عمدتاً به منظور محاسبه حد، انتگرال و مشتق گیری به کار می روند.



مثال

Commands	Results	Comments
`x=sym('x')`	`x= x`	Definition of the symbolic variable x.
`a=limit(sin(x)/x,0)`	`a = 1`	Computation of $\lim_{x\to 0}(\sin(x)/x)$.
`syms y z w`		Easy way to define multiple symbolic variables.

`y`
`z`
`w`
	`y = y`
	`z = z`
	`w = w`
		Confirmation that y, z, and w are symbolic variables.

`A=[x 2*y; z-w,z+w]`	`A = [x, 2*y]` `[z-w, z+w]`	Symbolic matrices can be also defined.
`det(A)`	`ans = x*z+x*w-2*y*z+2*y*w`	The determinant of **A**.
`F= 2*x^2+3*x+4`	`F = 2*x^2+3*x+4`	Polynomial of symbolic variables. The use of dot operator before the power operator is not necessary since x is not a vector but a symbolic variable. F is called a symbolic expression.

مشتق گیری از توابع

- diff(f): دیفرانسیل گیری ا زتابع f
- diff(f,n): دیفرانسیل گیری مرتبه n از تابع f

```
clear all;
clc;
t = [-5:0.1:5];
f = t.*cos(2*pi*t);
plot(t,f);
```

مثال:

- مشتق تابع زیر را محاسبه نمایید:

$$f(x,y) = e^{-x}\cos(y)$$

Commands	Results	Comments
`syms x y`		Declaration of the symbolic variables x and y.
`f=exp(-x)*cos(y)`	`f = exp(-x)*cos(y)`	The function $f(x, y)$ is a symbolic expression.
`diff(f,x)`	`ans = -exp(-x)*cos(y)`	Partial derivative $\partial f/\partial x$.
`diff(f,y)`	`ans = -exp(-x)*sin(y)`	Partial derivative $\partial f/\partial y$.
`diff(f,x,2)`	`ans= exp(-x)*cos(y)`	Second derivative of f with respect to x.
`t=diff(f,x)` `diff(t,x)`	`t = -exp(-x)*cos(y)` `ans = exp(-x)*cos(y)`	Alternative computation of the second derivative of f with respect to x. The result of the first derivative is assigned to variable t and the derivative of t is the desired result.

انتگرال گیری

- int(f): انتگرال گیری از تابع f
- int(f,variable,lower-limit,upper-limit)

مثال:

Commands	Results	Comments
`syms x t`		Declaration of the symbolic variables x and t.
`f=x^2` `g=x^2+exp(-t)`	`f = x^2` `g = x^2+exp(-t)`	The functions $f(x) = x^2$ and $g(x,t) = x^2 + e^{-t}$ are defined as symbolic expressions.
`int(f,x)`	`ans = 1/3*x^3`	Computation of $\int x^2 dx$.
`pretty(ans)`	$1/3\ x^3$	The command `pretty` prints symbolic output in a format that resembles typeset mathematics.
`int(f,x,-1,1)`	`ans = 2/3`	Computation of $\int_{-1}^{1} x^2 dx$.
`int(exp(-x^2),x,-inf, inf)`	`ans = pi^(1/2)`	Computation of $\int_{-\infty}^{\infty} e^{-x^2} dx$. To define $\pm\infty$ in MATLAB we write $\pm$ `inf`. Note that the function can be directly defined inside the command `int`.
`z=int(g,x)` `int(z,t)`	`z = 1/3*x^3+exp(-t)*x` `ans = 1/3*x^3*t-exp(-t)*x`	Computation of the double indefinite integral $\int\int g(x,t)dxdt$.

جمع سیمبولیک

Commands	Results	Comments

`syms w k`
`f=w^k`
`symsum(f,k,0,inf)`
	`f = w^k`
	`ans = -1/(w-1)`
		Computation of $\sum_{k=0}^{\infty} w^k$.
		The result is $1/(1-w)$.

فرم منطقی

Commands	Results	Comments
`syms x`		Definition of the symbolic variable x.
`f=(x^2)/(x+4)+3/(x-3)`	`f = x^2/(x+4)+3/(x-3)`	The complicated written function is $f(x)=\frac{x^2}{x+4}+\frac{3}{x-3}$.
`[n,d]=numden(f)`	`n = x^3-3*x^2+3*x+12` `d = (x+4)*(x-3)`	The numerator and denominator of the rational form of $f(x)$, or in other words, $f(x)=\frac{x^3-3x^2+3x+12}{(x+4)(x-3)}$.

حل معادلات جبری

Commands	Results	Comments
`syms x`		Definition of the symbolic variable x.
`f=x^2+6*x+5`	`f = x^2+6*x+5`	The expression $x^2+6x+5=0$ is assigned to variable f.
`solve(f,x)`	`ans = [-5]` `[-1]`	Solving f for x. The roots are -5 and -1.
`solve('x^2+6*x+5=0',x)`	`ans = -1` `-5`	Direct computation of the solution of equation $x^2+6x+5=0$.

```
solve('eqn1','eqn2', . . . ,' eqnN','var1,var2, . . . ,varN')
```

$$y = 2x + 3 \text{ and } y = 4x + 5$$

Commands	Results	Comments
`[x,y] = solve('y=2*x+3','y=4*x+5','x,y')`	`x = -1` `y = 1`	Solution of a system of algebraic equations. Notice that it is not necessary to declare symbolic variables in order to use the command `solve`. Also notice that it is possible to assign the output of `solve` to a variable.

نمایش اعداد مختلط:

- برای نمایش دامنه از: abs()
- برای نمایش زاویه از : angle()
- برای نایش بخش حقیق از: real()
- برای نمایش بخش موهومی از: imag()