



Programarea si utilizarea calculatoarelor II

Calcul simbolic in MATLAB

La ce se poate folosi calculul simbolic? Si de ce?

- Simplificari ale unor ecuatii
- Substitutii
- Estimarea preciziei de conversie
- Derivari
- Integrari
- Rezolvarea unor ecuatii
- Plotari

Definierea unor functii simbolice

Variabilele simbolice se introduc (definesc) cu ajutorul functiei **syms**

```
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.

>> clear all
>> syms x
>> f1=x^2+2*x-3

f1 =
x^2 + 2*x - 3

>> f2=4*x^2-x+2

f2 =
4*x^2 - x + 2

fx >>
```

Calculare si Simplificari

Operatiile se efectueaza in acelasi mod ca si in cazul ecuatiilor algebrice numerice dar rezultatul va fi in functie de variabil(a)/(ele) simbolice.

```
f_sum =
```

```
5*x^2 + x - 1
```

```
 $f_x$  >>
```

```
f_prod =
```

```
(x^2 + 2*x - 3) * (4*x^2 - x + 2)
```

```
 $f_x$  >>
```

Calcole si Simplificari

Command Window

 New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#).

```
>> f1=[x^2 -2 3*x]
?? Undefined function or variable 'x'.
```

```
>> syms x
>> f1=[x^2 -2 3*x]
```

```
f1 =
[ x^2, -2, 3*x]
```

```
>> syms y
>> ff=y*f1
```

```
ff =
[ x^2*y, -2*y, 3*x*y]
```

```
fx >>
```

Calcul
vectorial

Calcole si Simplificari

```
Command Window
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>> syms x,y
??? Undefined function or variable 'y'.

>> syms x y
>> A=[x y 1; x 1 y; 0 x 0];
>> B=[x y 1; 1 x y; x 0 y];
>> C_sum=A+B

C_sum =

[ 2*x, 2*y, 2]
[ x + 1, x + 1, 2*y]
[ x, x, y]

>> C_prod=A*B

C_prod =

[ x^2 + x + y, 2*x*y, y^2 + y + x]
[ x^2 + y*x + 1, x + x*y, y^2 + y + x]
[ x, x^2, x*y]

fx >>
```

Calcul
matriceal

Calculare si Simplificari

Datorita faptului ca prin operatiile matematice se pot obtine, de foarte multe ori, rezultate complexe, acestea pot fi prelucrate, si scrise in anumite forme cu ajutorul functiilor de simplificare:

collect, expand, horner, factor, simplify, simple

Simplificari - collect

Command Window

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```
>> syms x y
>> f1=(x+1)*(x+2)*(x+3)
```

```
f1 =
(x + 1)*(x + 2)*(x + 3)
```

```
>> f2=x^2+y^2+3;
>> f1*f2
```

```
ans =
(x + 1)*(x + 2)*(x + 3)*(x^2 + y^2 + 3)
```

```
>> collect(ans)
```

```
ans =
x^5 + 6*x^4 + (y^2 + 14)*x^3 + (6*y^2 + 24)*x^2 + (11*y^2 + 33)*x + 6*y^2 + 18
```

```
>> collect(f1)
```

```
ans =
x^3 + 6*x^2 + 11*x + 6
```

Gruparea termenilor
dupa puterile
variabilelor simbolice

Simplificari - expand

```
Command Window
New to MATLAB? Watch this Video, see Demos, o

>> syms x y
>> f1=(x+1)*(x+2)*(x+3);
>> f2=cos(x+y);
>> f3=(1+x)*y+x*y;
>> expand(f1)

ans =

x^3 + 6*x^2 + 11*x + 6

>> expand(f2)

ans =

cos(x)*cos(y) - sin(x)*sin(y)

>> expand(f3)

ans =

y + 2*x*y
```

Gruparea termenilor
dupa variabilele
simbolice si scrierea
ecuatiei din sume si
produse

Simplificari - horner

Command Window

 New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#).

```
>> syms x y
>> f1=(x+1)*(x+2)*(x+3);
>> f2=cos(x+y);
>> horner(f1)
```

```
ans =
x*(x*(x + 6) + 11) + 6
```

```
>> horner(f2)
```

```
ans =
cos(x + y)
```

```
>> f3=(1+x)*y+x*y;
>> horner(f3)
```

```
ans =
y + 2*x*y
```

```
>> horner(f1*f2)
```

```
ans =
6*cos(x + y) + x*(11*cos(x + y) + x*(6*cos(x + y) + x*cos(x + y)))
```

```
>> horner(f1*f3)
```

```
ans =
6*y + x*(23*y + x*(28*y + x*(13*y + 2*x*y)))
```

```
 $f_x$  >> |
```

Scrive o functie polinomiala
utilizand schema lui Horner


Simplificari - factor

Command Window	Command Window
<pre>>> syms x; f = x^3 - 6*x^2 + 11*x - 6; >> factor(f) ans = (x - 3)*(x - 1)*(x - 2) >> f2 = x^3 - 6*x^2 + 11*x - 5; >> factor(f2) ans = x^3 - 6*x^2 + 11*x - 5</pre>	<pre>>> syms x; >> f1=x^2-1; >> f2 = x^2+1; >> factor(f1) ans = (x - 1)*(x + 1) >> factor(f2) ans = x^2 + 1</pre>

scrie o funcție sub forma unui produs polinomial de grad inferior cu coeficienți raționali. Dacă funcția nu poate fi factorizată utilizând numere raționale, funcția rămâne neschimbată.

Simplificari - simplify

Command Window

 New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#)

```
>> syms x;  
f = x*(x*(x - 6) + 11) - 6;  
>> f2=(1 - x^2)/(1 - x);  
>> f3 = cos(x)^2 + sin(x)^2;  
>> simplify(f1)  
??? Undefined function or variable 'f1'.
```

```
>> simplify(f)
```

```
ans =
```

```
(x - 1)*(x - 2)*(x - 3)
```

```
>> simplify(f2)
```

```
ans =
```

```
x + 1
```

```
>> simplify(f3)
```

```
ans =
```

```
1
```

Command Window

 New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#)

```
>> f1=x^4-1
```

```
f1 =
```

```
x^4 - 1
```

```
>> f2=x^2+1;
```

```
>> f3=f1/f2
```

```
f3 =
```

```
(x^4 - 1)/(x^2 + 1)
```

```
>> simplify(f3)
```

```
ans =
```

```
x^2 - 1
```

```
fx >> |
```

Simplificari - simple

Command Window

 New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#).

```
>> syms x y
>> f1=x^2+2*x*y+y^2;
>> simple(f1)
```

simplify:

```
(x + y)^2
```

radsimp:

```
x^2 + 2*x*y + y^2
```

simplify(100):

```
(x + y)^2
```

combine(sincos):

```
x^2 + 2*x*y + y^2
```

```
rewrite(tan):
```

```
x^2 + 2*x*y + y^2
```

```
mwcoss2sin:
```

```
x^2 + 2*x*y + y^2
```

```
collect(x):
```

```
x^2 + (2*y)*x + y^2
```

```
ans =
```

```
(x + y)^2
```

```
>> f1=simple(f1)
```

```
f1 =
```

```
(x + y)^2
```

O metoda "neortodoxa" de verificare a celei mai scurte expresii (din pdv al numarului de caractere) care se poate obtine prin aplicarea unei functii de simplificare.

Substitutii de variable sau expresii

In ecuatiile simbolice se pot face substitutii (inlocuiri) de variabile simbolice sau de expresii, pentru a reduce expresia sau calcula expresia pentru o anumita valoare a variabilelor simbolice

Functii:

subexpr

subs

Substitutii - subexpr

```
>> syms x y
>> f1=x^2+2*x*y+y^2;
>> f2=f1^2

f2 =

(x^2 + 2*x*y + y^2)^2

>> simplify(f2)

ans =

(x + y)^4

>> r=subextr(ans)
??? Undefined function or method 'subextr' for input arguments of type 'sym'.

>> r=subexpr(ans)

sigma =

x + y

r =

sigma^4
```

Substitutii - subs

```
>> syms a b c x y
>> f1=a*x^2+b*x+c
```

```
f1 =

a*x^2 + b*x + c
```

```
>> a=2 b=4 c=5
??? a=2 b=4 c=5
```

```
      |
Error: Unexpected MATLAB expression.
```

```
>> a=2; b=4; c=5;
>> subs(f1)
```

```
ans =

2*x^2 + 4*x + 5
```

```
>> x=5;
>> subs(f1)
```

```
ans =

75
```

```
>> x=1:0.44:85;
>> subs(f1)
```

```
ans =

1.0e+004 *

Columns 1 through 9

0.0011    0.0015    0.0020    0.0025    0.0031    0
```

iniocuieste și calculeaza funcția simbolică cu valoarea dată pentru variabil(a)/ele simbolice.

Derivarea ecuatiilor simbolice

```
>> syms x y
>> f1=x^2+y^2;
>> f1_x=diff(f1,'x')
```

```
f1_x =
```

```
2*x
```

```
>> f1_der=diff(f1,'x')+diff(f1,'y')
```

```
f1_der =
```

```
2*x + 2*y
```

```
>> syms a b c
```

```
>> f2=a*x^2+b*x+c;
```

```
>> f2_d1=diff(f2,'x')
```

```
f2_d1 =
```

```
b + 2*a*x
```

```
>> f2_d2=diff(f2_d1,'x')
```

```
f2_d2 =
```

```
2*a
```

Integrarea ecuatiilor simbolice

```
>> syms a b c x
>> f1=x^2;
>> int(f1)
```

ans =

$x^3/3$

```
>> f1=a*x^2+b*y+c
```

```
??? Undefined function or variable 'y'.
```

```
>> syms y
```

```
>> f1=a*x^2+b*y+c
```

f1 =

$a*x^2 + c + b*y$

```
>> int(f1,'x')
```

ans =

$(a*x^3)/3 + (c + b*y)*x$

```
>> int(f1,'y')
```

ans =

$(b*y^2)/2 + (a*x^2 + c)*y$

f_x >> |

Rezolvarea ecuatiilor algebrice - solve

```
>> syms a b c x
>> f1=a*x^2+b*x+c;
>> solve(f1)
```

```
ans =

-(b + (b^2 - 4*a*c)^(1/2))/(2*a)
-(b - (b^2 - 4*a*c)^(1/2))/(2*a)
```

```
>> solve(f1,a)
```

```
ans =

-(c + b*x)/x^2
```

```
>> solve(f1,b)
```

```
ans =

-(a*x^2 + c)/x
```

```
>> a=1; b=-2; c=1;
>> solve(subs(f1))
```

```
ans =

1
1
|
```

```
|
>> subs(f1)

ans =

x^2 - 2*x + 1

fx >>
```