

وزارة التعليم
جامعة طيبة
كلية العلوم
قسم الرياضيات

MATLAB Workshop
Department of Mathematics

7/7/1436 (2015)

Meeting 1:
Introduction to Matlab, Command window

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مقدمة

•كلمة MATLAB هي اختصار للتعبير MATrix LABoratory (مختبر المصفوفة) وهو احد البرنامج الأشهر في الأوساط العلمية لما له من مزايا الاستخدام ولسهولة استعماله.

•حيث يمكن من حل العديد من المسائل التقنية خاصة التي تحتاج إلى جهد كبير لبرمجتها بلغات البرمجة الأخرى مثل لغة C, C++و FORTAN...

•يتيح البرنامج معالجة وحل تطبيقات علمية باستعمال الادواة toolboxes (وهي أكثر من عشرين أداة)، مخصصة لمعالجة مشكلات ومسائل مثل معالجة الإشارة, ونظم التحكم والمحاكاة والشبكات العصبية والتحليل الكمي والمالي والإحصاء ومسائل الجبر الخطي والامثلية الرسوم البيانية... الخ.

• يؤمن أدوات التخاطب الرسومية Graphical User Interface (GUI) التي تجعل التعامل مع البرنامج على انه أداة تطبيقية متطورة.

•يمكن استعماله في البرمجة المتقدمة باستعمال اسس وقواعد البرمجة الاعتيادية للغات الاخرى ك C, C++و FORTAN...

Contents:

- How to enter vectors and matrices
- Properties of Matrices
- Operators (arithmetic) for numbers
- The use of "dot-Element" Operation
- Generating Vectors from functions
- Entries of matrices and vectors
- Simple Arithmetic
- Polynomials and Functions
- Solving equation and linear systems
- Useful Commands
- Elementary Math Function
- Learning More

How to enter matrices and vectors

- a vector

```
>>x = [1 2 5 1]

   x =
         1    2    5    1
```

ماتلاب يخزن x
ثم يظهر قيم المتجهة

- a matrix

```
>>X = [1 2 3; 5 1 4; 3 2 -1]

   X =
         1     2     3
         5     1     4
         3     2    -1
```

ماتلاب يخزن X
ثم يظهر قيم المصفوفة

- transpose

```
>> y = x'
y =
     1
     2
     5
     1
```

ماتلاب يخزن y
ثم يظهر قيم تدوير المتجهة

How to enter matrices and vectors

- a vector `>> x = [1 2 5 1];`

ماتلاب يخزن x
ولا يظهر قيم المتجهة
نظرا لوجود ;

- a matrix `>> x = [1 2 3; 5 1 4; 3 2 -1];`

ماتلاب يخزن x
ثم لا يظهر قيم المصفوفة

- transpose `>> y = x';`

ماتلاب يخزن y
ثم لا يظهر قيم المتجهة العمود

```
If you recall x the output will be    the column vector with
  entries 1 2 3 and 1
```

Matrices and their entries

x(i,j) subscription >>y=x(2,3)

```
y =

     4
```

whole row >> y=x(3,:)

```
y =

     3     2    -1
```

whole column >> y=x(:,2)

```
y =

     2

     1

     2
```

```
x =
     1     2     3
     5     1     4
     3     2    -1
```

ماتلاب يظهر قيمة الصف 2والعمود 3

```
x =
     1     2     3
     5     1     4
     3     2    -1
```

ماتلاب يظهر قيم الصف 3

```
x =
     1     2     3
     5     1     4
     3     2    -1
```

ماتلاب يظهر قيم العمود 2

Operators (arithmetic) for numbers

العمليات الحسابية الاعتيادية بين الأعداد فقط دون المصفوفات

+ addition: element + element

ex. >>2+3 Result 5

- Subtraction: element - element

ex. >>2-3 Result -1

* Multiplication: element * element

ex. >>2*3 Result 6

/ division: element + element

ex. >>2/3 Result 1.66666

^ power: element + element

ex. >>2^3 Result 8

Operators (arithmetic) for matrices

Element by element .* ./ .^

```
.*      element-by-element mult
>> x=[1 2];
>> x.*x                    (ans:  1*1    2*2)
ans =
    1    4
```

```
./     element-by-element div
>> y=[10 20];
>> y./x                    (ans:  10/1    20/2)
ans =
    10    10
```

```
.^          element-by-element power
>> y.^x
ans =                              (ans:  10^1    20^2)
    10   400
```

All results are not saved !!!!! To do this define a variable name for example >>z= y.^x

The use of "dot-Element" Operation

```
>>A = [1 2 3; 5 1 4; 3 2 1]
   A =
        1    2    3
        5    1    4
        3    2   -1
```

الاستعمال الصحيح لعملية الضرب بين عناصر ماتلاب

```
>>x = A(1,:)
x=
   1   2   3
```

```
>>y = A(3 ,:)
y=
    3  4  -1
```

```
>>b = x .* y
b=
     3  8 -3
```

```
>>c = x . / y
c=
   0.33   0.5   -3
```

```
>>d = x .^2
d=
      1    4    9
```

```
>>K= x^2
Erorr:
??? Error using ==> mpower  Matrix must be square.
>>B=x*y
Erorr:
??? Error using ==> mtimes Inner matrix dimensions must agree.
```

Generating Vectors from functions

- zeros(m,n) mxn matrix of zeros
- ones(m,n) mxn matrix of ones
- rand(m,n) mxn matrix of uniformlydistributed random numbers on (0,1)

```
>>x = zeros(1,3)
x =
   0     0     0

>>x = ones(1,3)
x =
   1     1     1

>>x = rand(1,3)
x =
    0.9501   0.2311   0.6068
```

Entries of matrices and vectors

- [ ] concatenation

```
>> x = [ zeros(1,3) ones(1,2) ]
x =
     0   0   0   1   1
```

x is a vector with three zeros and two ones

- ( ) subscription

```
>>y = x(4)
y =
     1
```

y is the fourth component of the vector x

- `>>y = x(2:4)`

```
y =
     0   0   1
```

y is a vector consists of the 2nd, 3rd and the 4th elements of the vector x

Simple Arithmetic (Vectors)

Input	Output	Comment
>> a = [-1 2 3 4 2 3 2]; >> min(a) >> max(a)	 -1 4	Min and Max entries of vector
>> mean(a)	2.1429	Mean
>> median(a)	2	Median
>> diff(a)	3 1 1 -2 1 -1	Differences between consecutive entries 2-(-1) 3-1 4-3 2-4 3-2 2-3
>> var(a)	2.4762	Variance

Simple Arithmetic (Matrices)

Input	Output	Comment
>> A = [1 2; 2 7]; >> A'	ans = 1 2 2 7	Transpose of a matrix
>> A.^2	ans = 1 4 4 49	Square every element of matrix
>> inv(A)	ans = 2.3333 -0.6667 -0.6667 0.3333	Inverse of matrix
>> det(A)	ans = 3	Determinant of matrix
>> [v,d] = eig(A)	v = -0.9571 0.2898 0.2898 0.9571 d = 0.3944 0 0 7.6056	Eigenvector and eigenvalues of a matrix

Polynomials

>>p=[4 2 -6];	Define the polynomial p(x)=4x^2+2x-6
>>roots(p) ans = -1.5000 1.0000	Find the roots of a polynomial whose coefficients are given in p
>>roots([1 4 2.1]) ans = -3.3784 -0.6216	Find the roots of x^2+4x+2.1=0
>>polyval(p,a) >>polyval(p, 1)=0 >>polyval(p, -1.5)=0 >>polyval(p, sqrt(13))= 53.2111	Evaluate the polynomial whose coefficients are given in p at x=a

Polynomials

>>p1=[1 2 3] >>p2=[0 5 8] >>p=p1+p2	Define the polynomial p1(x)=x2+2x+3 p2(x)=5x+8 p is the sum of p1 and p2 The output is p(x)=x^2+10x+11
>>r=[1 2] >>p=poly(r) p = 1 -3 2	Define the polynomial whose roots are 1 and 2 The result is p(x)=1x^2-3x+2
>>p=poly([-1.23 2.13]) p = 1.0000 -0.9000 -2.6199	Define the polynomial whose roots are -1.23 and 2.13 The result is p(x)=1.0x^2-0.90x-2.6199

Polynomials Higher degree

>>roots([1 -10 35 -50 24]) ans = 4.0000 3.0000 2.0000 1.0000	Find the roots of the polynomial p(x)=x^4-10x^3+35x^2-50x+24
p=poly([1 2 3 4]) p = 1 -10 35 -50 24	Find the roots of a polynomial whose coefficients are given in p
>> roots([1 -10 35 -5 2]) ans = 4.9344 + 3.0492i 4.9344 - 3.0492i 0.0656 + 0.2348i 0.0656 - 0.2348i	Complex zeros of the polynomial p(x)=x^4-10x^3+35x^2-5x+2

Functions (one dimensional)

Input	Output	Comment
>> f = inline('3+2*x.^2');	Nothing	but the function is saved
>> f	f = Inline function: f(x) = 3+2*x.^2	How f is defined
>> formula(f)	ans = 3+2*x.^2	The function expression
>> f(0)	ans = 3	Evaluation of f at x=0
>> f(-1)	ans = 5	Evaluation of f at x=-1
>> a=2; f(a)	ans = 11	Recalling a constant and evaluation of the inline function f at a

Functions (Multi-dimensional)

Input	Output	Comment
>> f = inline('3*t+2*x.^2','t','x');	>> f f = Inline function: f(t,x) = 3*t+2*x.^2.^2	Two dimensional analytical expression of f(t,x) One should define the variables
>> f(1,-1)	ans = 5	Evaluation of f at t=1 and x=-1
>> g = inline('(x.^2+y.^2+z.^2)','x','y','z')	g = Inline function: g(x,y,z) = (x.^2+y.^2+z.^2)	Three dimensional analytical expression of g(x,y,z)
>> g(pi,2*pi,-pi)	ans = 59.2176	Evaluation of f at g(pi,2*pi,-pi)

Functions (other forms)

Input	Output	Comment
>> f =@(x) 3+2*x.^2	>> f f = @(x)3+2*x.^2	Inline function one dim
>> f(-1)	ans = 5	Evaluation of f at x=-1
>> f =@(t,x) 3*t+2*x.^2;	>> f f = @(t,x) 3*t+2*x.^2	Two dimensional analytical expression of f(t,x)
>> f(1.5,-1.2)	ans = 7.3800	Evaluation of f at (t,x)=(1.5,-1.2)
>>f(1,4)-f(1,3)	ans = 14	Sum of two evaluation
>> f([1 2 3],[4 5 6])	ans = 35 56 81	Evaluation elemet by element at (x,y)=(1,4) (x,y)=(2,5) (x,y)=(3,6)

Solving equation

Input	Output	Comment
>> x=solve('x^2+4*x-5=0')	x = -5 1	Return the solution of the second order equation x^2+4*x-5=0
x=solve('x^3+x-2=0')	x = 1 - (7^(1/2)*i)/2 - 1/2 (7^(1/2)*i)/2 - 1/2	Return the solution of the third order equation x^3+x-2=0
x=solve('x^2+t*x-2=0','x')	x = - t/2 - (t^2 + 8)^(1/2)/2 (t^2 + 8)^(1/2)/2 - t/2	Return the solution of the second order equation with parameter t, x^2+t*x-2=0
>> B=solve('x^2+t*x-2=0','t')	B = -(x^2 - 2)/x	Return the solution of the first order equation with parameter x, x^2+t*x-2=0
>> eq = 'x^2 -7*x + 12 = 0'; >> s = solve(eq);	>> disp('The first root is: '), disp(s(1)); The first root is: 3	Return a comment TEXT And the first root of the given equation
>> eq = 'x^2 -7*x + 12 = 0'; >> s = solve(eq);	>> disp('The second root is: '), disp(s(2)); The second root is: 4	Return a comment TEXT And the second root of the given equation

Solving linear systems

Input	Output	Comment
>> A = [5, 9; 3, -6]; >> b = [5;4]; >> x=A \ b	x = 1.1579 -0.0877	Return the solution of the linear system 5x + 9y = 5 3x – 6y = 4
>> A=[1 3 -2;3 5 6;2 4 3]; >> b=[5;7;8]; >> x=A\b	x = -15.0000 8.0000 2.0000	Return the solution of the linear system x + 3y -2z = 5 3x + 5y + 6z = 7 2x + 4y + 3z = 8
>> x=inv(A)*b	x = -15.0000 8.0000 2.0000	Return the solution of the linear system above by using the inverse function

Useful Commands

>> help abs **ABS(X) is the absolute value of the elements of X. When X is complex, ABS(X) is the complex modulus (magnitude) of the entries of X.** **See also sign, angle, unwrap.** **This is useful when you know the exact MATLAB command. It will help you with the syntax etc.**
>> clear **This command removes all variables from the current workspace**
>> exit **This command lets you exit from MATLAB**

Useful Commands

>> a = 2; b = 3; >> who Your variables are: a b Displays all the variables you have introduced in the workspace. “whos” gives more detailed information on the variables
>> save My a b Saves variables a and b to file My.mat
>> load My Loads the variables from the file My.mat

Elementary Math Function

Number operation: x is a real number

Abs(x), sign(x)

Sin(x), cos(x),

asin(x) (inverse fct of sin(x)), acos(x)

Exp(x), log(x), log10(x), Sqrt(x)

Vector operation: b is a vector

Max(b), min(b): max/min element of a vector

Mean(b), median(b)

Std(b), var(b): standard deviation and variance

Sum(b), prod(b): sum/product of elements

Sort(b): sort in ascending order

THANKS