MATLAB Basics

在此主要介紹 MATLAB 命令窗口(Command Window)的使用方法，包括矩陣變數與常用計算。

1. 變數與矩陣

```
>>                                  %   >> 爲命令游標 (command prompt)
```

```
>> variable=expression              % 變數內容指定

>> A=[1 2; 4 6] < ret >             %   <ret> 代表 Enter 鍵
A =
1 2
4 6
```

```
>>A=[1 2;4 6];                      % 分號抑制輸出顯示
>>
>>A=[1 2;4 6]                       % 沒有分號的情況
A =
1 2
4 6
```

Table A.1 Mathematical Operators

+	Addition
−	Subtraction
*	Multiplication
/	Division
^	Power

```
數學運算子: 加 +, 減 –, 乘 *, 除 /, 次方^ (Mathematical Operators)

>> 12.4 / 6.9
ans =
1.7971
```

常用數學函數

Table A.2 Common Mathematical Functions

sin(x)	Sine	acoth(x)	Inverse hyperbolic cotangent
sinh(x)	Hyperbolic sine	exp(x)	Exponential
asin(x)	Inverse sine	log(x)	Natural logarithm
asinh(x)	Inverse hyperbolic sine	log10(x)	Common (base 10) logarithm
cos(x)	Cosine	log2(x)	Base 2 logarithm and dissect floating point number
cosh(x)	Hyperbolic cosine	pow2(x)	Base 2 power and scale floating point number
acos(x)	Inverse cosine	sqrt(x)	Square root
acosh(x)	Inverse hyperbolic cosine	nextpow2(x)	Next higher power of 2
tan(x)	Tangent	abs(x)	Absolute value
tanh(x)	Hyperbolic tangent	angle(x)	Phase angle
atan(x)	Inverse tangent	complex(x,y)	Construct complex data from real and imaginary parts
atan2(y,x)	Four quadrant inverse tangent	conj(x)	Complex conjugate
atanh(x)	Inverse hyperbolic tangent	imag(x)	Complex imaginary part
sec(x)	Secant	real(x)	Complex real part
sech(x)	Hyperbolic secant	unwrap(x)	Unwrap phase angle
asec(x)	Inverse secant	isreal(x)	True for real array
asech(x)	Inverse hyperbolic secant	cplxpair(x)	Sort numbers into complex conjugate pairs
csc(x)	Cosecant	fix(x)	Round towards zero
csch(x)	Hyperbolic cosecant	floor(x)	Round towards minus infinity
acsc(x)	Inverse cosecant	ceil(x)	Round towards plus infinity
acsch(x)	Inverse hyperbolic cosecant	round(x)	Round towards nearest integer
cot(x)	Cotangent	mod(x,y)	Modulus (signed remainder after division)
coth(x)	Hyperbolic cotangent	rem(x,y)	Remainder after division
acot(x)	Inverse cotangent		

變數大小寫有別 (Variables are case sensitive.)

```
>>M=[1 2];
>>m=[3 5 7];
```

```
>>who
Your variables are:
A M ans m z
```

函式或指令大小寫有別(Function names are case sensitive.)

```
>>WHO
??? Undefined
function or variable 'WHO'.
>>Who
??? Undefined function or
variable 'Who'.
```

```
>>whos
Name      Size      Bytes      Class      Attributes
   A      2x2        32        double
   M      1x2        16        double
 ans      1x1         8        double
   m      1x3        24        double
   z      1x1        16        double      complex

>>clear A
>>who
Your variables are:
M ans m z
```

內定符號

pi	圓周率
i, j	根號-1
Inf	無窮大
NaN	Not-a-Number

```
>>pi
ans =
3.1416

>>z=3+4*i
z =
3.0000 + 4.0000i

>> 3 / 0
Warning: Divide by zero.
ans =
     Inf

>>0/0
Warning: Divide by zero
ans =
NaN
```

2. 矩陣運算

```
>>A=[1 2;4 5]                    % A 爲 2x2 矩陣
A =
1 2
4 5
```

```
>>A=[1 3; 5 9]; B=[4 -7; 10 0];
>>A+B                            % 矩陣相加
ans =
  5 -4
15 9

>>b=[1;5];
>>A*b                            % 矩陣相乘
ans =
16
50

>>A'                             % 矩陣轉置
ans =
1 5
3 9
```

```
>>x=[5;pi;sin(pi/2)]; y=[exp(-0.5);-13;pi^2];
>>x'*y                           % 向量內積
ans =
-27.9384

>>x*y'                           % 向量外積
ans =
3.0327 -65.0000 49.3480
1.9055 -40.8407 31.0063
0.6065 -13.0000 9.8696
```

```
>> A=[1 2 3;4 5 6;7 8 9]
A =
     1     2     3
     4     5     6
     7     8     9

>> A(2,3)
ans =
     6

>> A(2:3,1:2)
ans =
     4     5
     7     8

>> A(1,:)
ans =
     1     2     3

>> A(:,2)
ans =
     2
     5
     8
```

Exercise: (matrix element) 矩陣元素的標示

Check the difference between A(i,j) and A(.)

```
>> A=[1 2 3;4 5 6]
A =
     1     2     3
     4     5     6

>> a=A(1,3)                    % 全下標標示 (教科書型式)
a =
     3

>> b=A(5)                      % 單下標標示
b =
     3

>> A(:)
ans =
     1
     4
     2
     5
     3
     6

>> B=A>5                       % 邏輯 1 標示
B =
     0     0     0
     0     0     1

>> c=A(B)
c =
     6
```

Check sub2ind and ind2sub

Table A.3 Mathematical Array Operators

+	Addition
−	Subtraction
.*	Multiplication
./	Division
.^	Power

矩陣元素個別運算

```
>>A=[1;2;3];B=[-6;7;10];
>>A.*B
ans=
-6
14
30

>>A.^2
ans =
1
4
9
```

3. 線性代數

數值線性代數

- Linear equation Ax=b
- Eigenvalue/ Eigenvector Ax=λx

求解線性方程式

```
>> A=[1 2 3;4 5 6;7 8 0];
>> b=[5 8 -7]';
>> x=A \ b
x =
    -1
     0
     2

>> A=[1 2 3; 4 5 6; 7 8 0];
>> b=[5 8 -7]';
>> x=inv(A)*b
x =
   -1.0000
         0
    2.0000
```

Other: det(A), trace(A), rank(A)

求解特徵值及特徵向量

```
>> A=[0 1; -1 0];
>> eig(A)
ans =
          0 +   1.0000i
          0 -   1.0000i

>> A=[0 1; -1 0];
>> [X,D]=eig(A)                    % diagonalizing X with such that X^-1*A*X = D
X =
   0.7071                  0.7071
          0 + 0.7071i             0 - 0.7071i
D =
          0 + 1.0000i             0
          0                       0 - 1.0000i
```

Exercise: Jordan form

```
>> A=[-1 -2 6;-1 0 3;-1 -1 4]

A =
     -1     -2      6
     -1      0      3
     -1     -1      4

>> [X,D]=eig(A)

X =
   -0.8165   -0.8165   0.8165
   -0.4082   -0.4082   0.4082
   -0.4082   -0.4082   0.4082

D =
    1.0000         0         0
         0    1.0000         0
         0         0    1.0000
```

Check that A*X=X*D. However, X is singular.

```
>> [V,J] = jordan(A)
V =
     -2      4      3
     -1      0      0
     -1      1      1

J =
      1      1      0
      0      1      0
      0      0      1

>> inv(V)*A*V              % or V\A*V = J

ans =
      1      1      0
      0      1      0
      0      0      1
```

Exercise: (complex number, transpose and conjugate transpose)

Assume a=1+j$\sqrt{3}$. How to input this number? How to compute its real part, imaginary part, length and argument? (Hint: Check command **real**, **imag**, **abs**, **angle**)

```
>> a=1+j*sqrt(3)
a =
    1.0000 + 1.7321i

>> real(a)
ans =
     1

>> imag(a)
ans =
    1.7321
```

```
>> abs(a)
ans =
     2.0000

>> angle(a)              % radian
ans =
     1.0472

>> angle(a)*180/pi       % degree
ans =
    60.0000
```

Check the difference between A' and A.'

A'　共軛轉置? (i.e., A*)　A.'　非共軛轉置? (i.e., A^T)

```
>> A=[3 2+i;1-i 2]
A =
    3.0000                  2.0000 + 1.0000i
    1.0000 - 1.0000i        2.0000

>> A'
ans =
    3.0000                  1.0000 + 1.0000i
    2.0000 - 1.0000i        2.0000

>> A.'
ans =
    3.0000                  1.0000 - 1.0000i
    2.0000 + 1.0000i        2.0000
```