Matlab Tutorial

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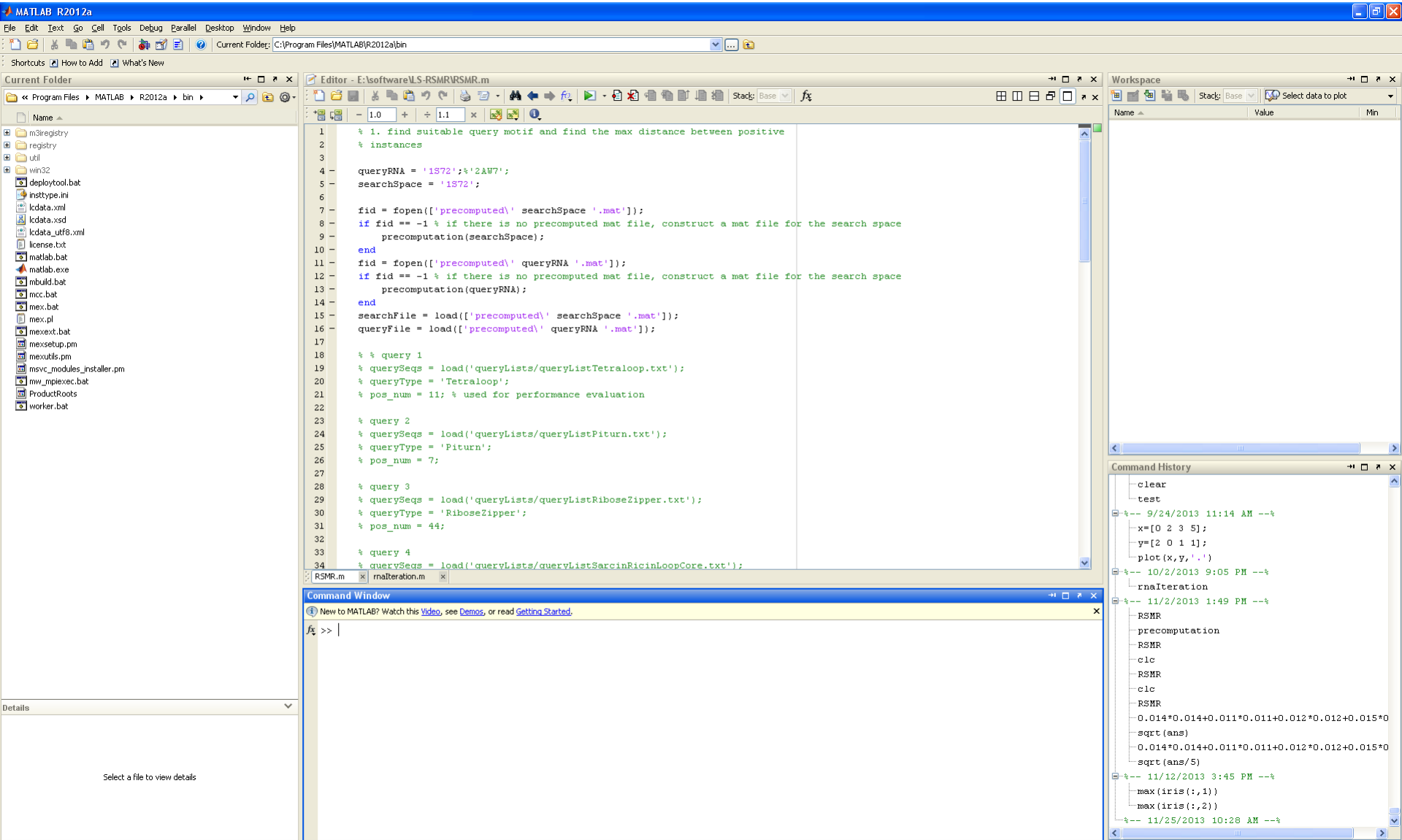
Matlab environment



Simple arithmetical operations

a+b	Addition.	a/b	Division.
a-b	Subtraction.	a\b	Left division, (this is exactly the same as b/a).
a*b	Multiplication	a^b	Exponentiation (i.e., a^b).

- $3.17 \times 5.7 + \frac{17}{3}$:

  >> 3.17*5.17+17/3

- 2×10^{-20}:

  >> 2*10^-20

  >> 2e-20; 2E-20

Variables

- $x = \sqrt[3]{2}$:

  >> x = 2^(1/3)

  >> fx = 3*x^6 - 17*x^3 + 79

  >> x = x + 5

- display variables:

  >> x

  >> disp(x)

- clear variable

  >> clear x

  >> clear

Variable

- Predefined variables:
  - ans
  - pi
  - eps
  - Inf/inf
  - NaN/nan
  - …

Common mathematical functions

- sin

  >> sin(3)

- exp

  >> exp(2)

- log/log2

  >> log(10)/log2(4)

- …
- Refer to the help document!

Matrix and vector

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

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

  or

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

- $x = \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{pmatrix}$

  >> x = [1;2;3;4;5;6];

  or

  >> x = [1 2 3 4 5 6]’

Matrix and vector

- Select an element:

  >> A(3,3): ans = 9

- Select several element:

  >> A(1:2;2:3): ans = $\begin{pmatrix} 2 & 3 \\ 5 & 6 \end{pmatrix}$

  >> x(3:5): ans = $\begin{pmatrix} 3 \\ 4 \\ 5 \end{pmatrix}$

  >> x(3:end)

- Get matrix/vector dimension:

  >> size(A); size(x): ans = 3 3; ans = 6 1

  >> length(x): ans = 6

Generating matrix

- C = zeros(3); C = zeros(3,3)

$$>> C = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

- C = zeros(3,5)

$$>> C = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

- C = ones(3); C = ones(3,3); C = ones(3,5)
- C = zeros(size(A))

Generating matrix

- repmat(A,2,3)

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

- cat(1,A,A); cat(2,A,A)

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

Generating vector

- x = [1 2 3 … 100]

  >> x = (1:1:100)

- x = [1 1.1 1.2 … 2] ??

Simple matrix operations

- A + B
  - means $A + B = (a_{ij} + b_{ij}) = (a_{ij} + b_{ij})$
- A – B
  - means $A - B = (a_{ij} - b_{ij}) = (a_{ij} - b_{ij})$
- c*A
  - means $cA = c(a_{ij}) = (c * a_{ij})$
- A*B
  - means $AB = (a_{ij})(b_{ij}) = (\sum_{k=1}^{l} a_{ik} b_{kj})$
- A^p
  - means $A^p = AA \ldots A$
- A\b (not recommended)
  - the solution of Ax=b;
  - using inv(A)*b instead
- A\B
  - solve AX=B by repeatedly solving Ax=b where b is each column of B in turn and x is the corresponding column of X

Simple matrix operations

- A.*B
  - means $(a_{ij} * b_{ij})$
- A./B
  - means (a_{ij}/b_{ij})
- B.\A
  - means A./B
- A.^p
  - means(a_{ij}^{p})

Data manipulation commands

- Maximum value of vector x
  >> m = max(x)
  >> [m i] = max(x)
- Maximum value of matrix A
  >> max(A): ans = 7 8 9
  >> max(A(:)): ans = 9
- The sum of the elements of the vector x
  >> sum(x)
- The average of the elements of x
  >> mean(x)
- Standard deviation of x
  >> std(x)
- Sort the elements of the vector x in increasing order
  >> sort(x)
- Euclidean distance of x
  >> norm(x)
- The matrix norm of A
  >> norm(A)

Graphics

- Plot the functions $y_1 = \sin(x)$ and $y_2 = e^{\cos(x)}$ for $x \in [0, 2\pi]$

```
>> n = 100
>> x = 2*pi*(0:n-1)'/(n-1)
>> y1 = sin(x)
>> y2 = exp(cos(x))
>> plot(x,y1)
>> plot(x,y2)
```

Input and output

- The matrix is input by using command:

  >> load <file name> or load ‘<file name>’ or load(‘<file name>’)

- Read in a file

  >> fid = fopen(‘iris.data’)

  >> fileContent = textscan(fid, ‘%f%f%f%f%s’, 'delimiter', ',')

  - fileContent is 1*5 cell
  - To index an element in fileContent: >> fileContent{i,j}

Flow control and logical variables

- for loop:

  for <variable> = <expression>
  <statement>
  ...
  <statement>
  end

- example:

```
x = zeros(n, 1);
for i = 1:n
    x(i) = i * sin( i^2 *pi/n );
end
```

- if statement:

  if <logical expression 1>
  <statement group 1>
  elseif <logical expression 2>
  <statement group 2>
  elseif <logical expression 3>
  <statement group 3>
  ...
  else <logical expression r>
  <statement group r>
  end

Logical Operators

`A & B`	AND.
`A | B`	OR.
`~A`	NOT.
`xor(A, B)`	EXCLUSIVE OR.

`a && b`	Short-circuit AND. Returns logical 1 (true) or 0 (false). Only evaluates `b` if `a` is true.
`a || b`	Short-circuit OR. Returns logical 1 (true) or 0 (false). Only evaluates `b` if `a` is false.

Flow control and logical variables

- while statement

```
while <logical expression>
        <statement>
        ...
        <statement>
end
```

- switch command

```
switch <variable or expression>
        case <Value 1>
                <statement group 1>
        case {<Value 2a>, <Value 2b>, <Value 2c>, ..., <Value 2m>}
                <statement group 2>
        ...
        case <value n>
                <statement group r>
        otherwise
                <statement group r+1>
end
```

Function M-files

- function <out> = <function name>(<in 1>, ..., <in n>)
- Example
  - Calculate the summation

$$S(n) = \sum_{k=0}^{n} \frac{1}{k^2 + 1}$$

How to improve your programming skills

- Help document
- Read codes from others