Introduction to Problem Solving with MATLAB

Department of Chemical Engineering
Indian Institute of Technology Roorkee

What is MATLAB?

- MATLAB is a powerful, interactive software tool that can be employed with relative ease in solving science and engineering problems
- Started in the 1970s. It has now evolved into a huge system comprising of built-in functions and toolboxes
- User community size $\geq$ 500,000 (industry, government & academia)
- More than 600 built-in functions (mathematical, statistical and engineering) that are reliable, accurate and fast

What is MATLAB?

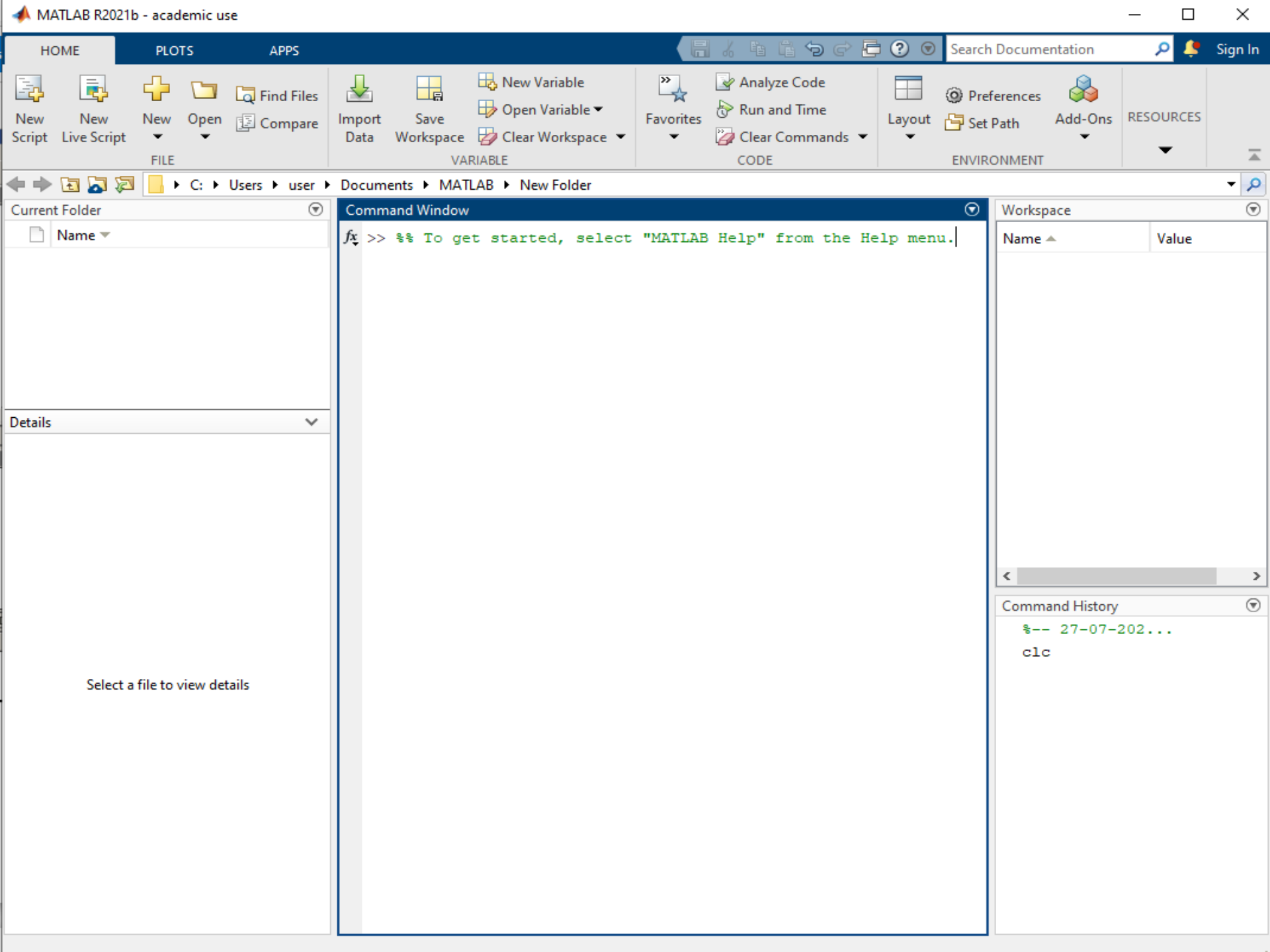
- You can use MATLAB built-in functions and other external resources to develop your own toolboxes – Third Party Products
- Excellent graphics to analyze and visualize your data. Can generate ps, eps, wmf, bmp, jpeg, tiff, …… files and insert figures into WORD, LATEX etc.
- Interfaces external languages, such as C, C++, Fortran, and Java. Can convert MATLAB to C & C++
- Support for importing data from files and external devices and for using low-level file I/O (plus access to databases and additional hardware via add-on products)

Disadvantages of MATLAB

- Cost – about 5~10 times more expensive than conventional Fortran or C compiler

- It is an interpreter-based language and not compiler-based. So, it executes programs line by line and not as a compiled object.
  - Can make MATLAB extremely slow, particularly with "loops"

- Can be overcome by properly structuring the MATLAB program or by using a MATLAB to C compiler to create an "executable".
  - This has the additional advantage that your source code can be protected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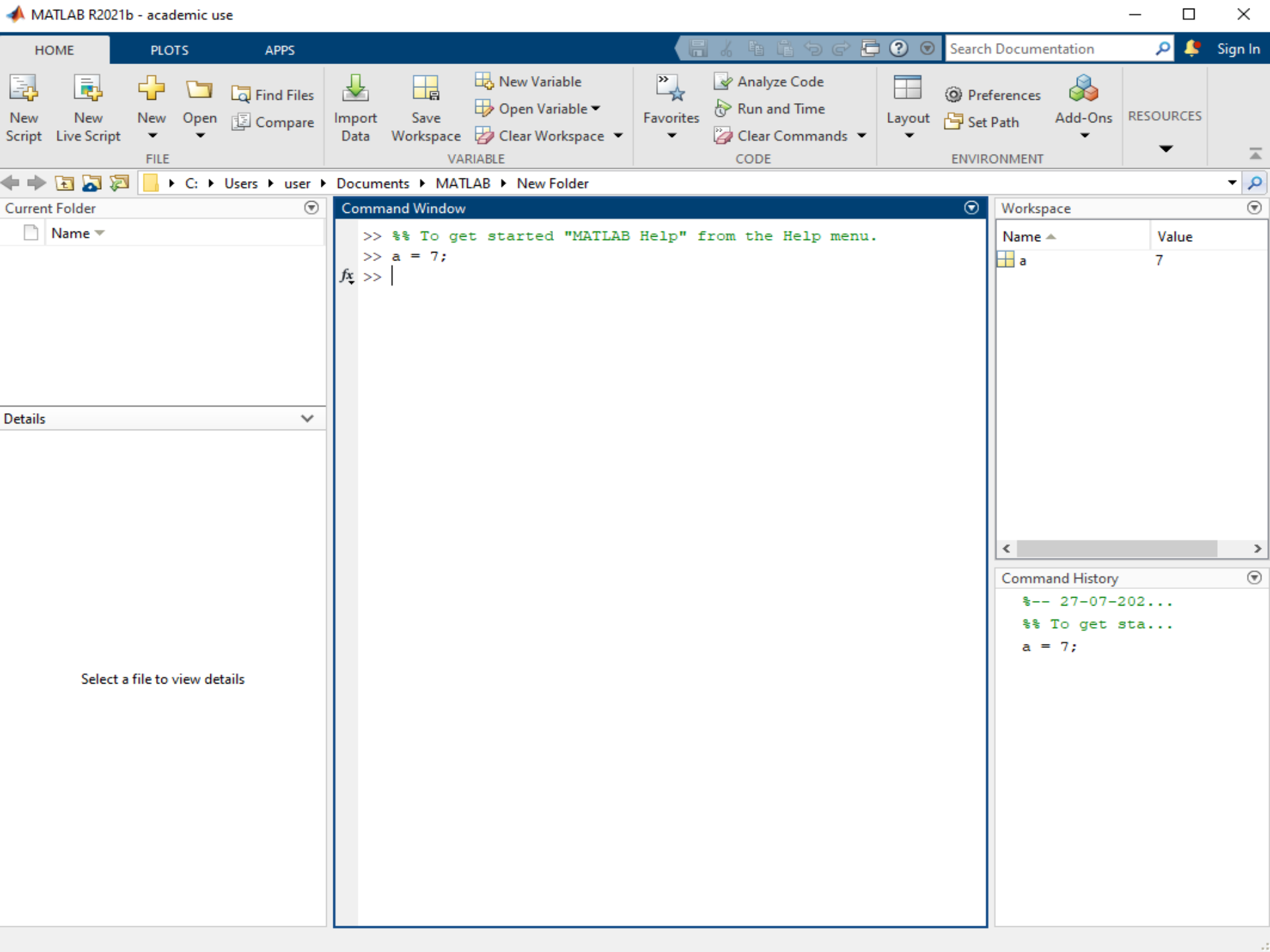
Command Window
>> %% To get started, select "MATLAB Help" from the Help menu.
Workspace
Name
Value
Command History
%-- 27-07-202...
clc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Add-Ons
ENVIRONMENT
RESOURCES
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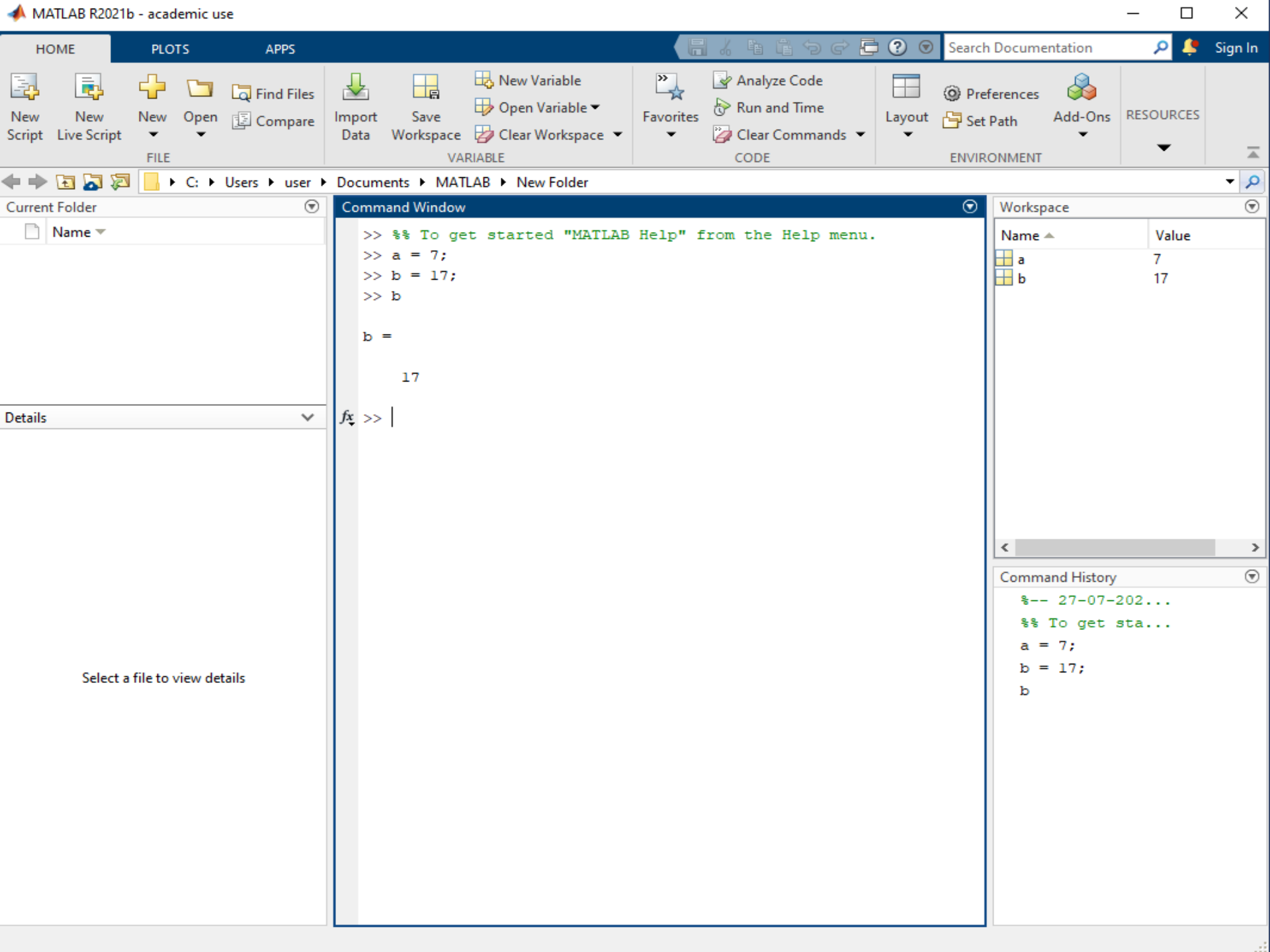
Current Folder
Name
Details
Select a file to view details
Command Window
>> %% To get started "MATLAB Help" from the Help menu.
>> a = 7;
>>
Workspace
Name
Value
a
7
Command History
%-- 27-07-202...
%% To get sta...
a = 7;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Current Folder
Name
Details
Select a file to view details
Command Window
>> %% To get started "MATLAB Help" from the Help menu.
>> a = 7;
>> b = 17;
>> b
b =
17
>>
Workspace
Name
Value
a
7
b
17
Command History
%-- 27-07-202...
%% To get sta...
a = 7;
b = 17;
b

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RESOURCES

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Current Folder

Name

Details

Select a file to view details

Command Window

```
>> %% To get started "MATLAB Help" from the Help menu.
>> a = 7;
>> b = 17;
>> b

b =

    17

>> c = a + b

c =

    24

>>
```

Workspace

Name	Value
a	7
b	17
c	24

Command History

```
%-- 27-07-202...
%% To get sta...
a = 7;
b = 17;
b
c = a + b
```

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Current Folder

Name

Details

Select a file to view details

Command Window

```
>> %% To get started "MATLAB Help" from the Help menu.
>> a = 7;
>> b = 17;
>> b

b =

    17

>> c = a + b

c =

    24

>> whos
  Name      Size              Bytes  Class     Attributes

  a         1x1                   8  double
  b         1x1                   8  double
  c         1x1                   8  double

>> %% Grand total is 3 elements using 24 bytes
>>
```

Workspace

Name	Value
a	7
b	17
c	24

Command History

```
%-- 27-07-202...
%% To get sta...
a = 7;
b = 17;
b
c = a + b
whos
%% Grand tota...
```

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Command Window

```
>> %% To get started "MATLAB Help" from the Help menu.
>> a = 7;
>> b = 17;
>> b

b =

    17

>> c = a + b

c =

    24

>> whos
  Name        Size              Bytes  Class     Attributes

  a           1x1                   8  double
  b           1x1                   8  double
  c           1x1                   8  double

>> %% Grand total is 3 elements using 24 bytes
>> clear
>>
```

Workspace

Name	Value

Command History

```
%-- 27-07-202...
%% To get sta...
a = 7;
b = 17;
b
c = a + b
whos
%% Grand tota...
clear
```

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Command Window

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

A =

     9     8     7
     6     5     4
     3     2     1

>> B = [18 17 16;15 14 13;12 11 10]

B =

    18    17    16
    15    14    13
    12    11    10

>> C = A + B

C =

    27    25    23
    21    19    17
    15    13    11

>> whos
  Name        Size              Bytes  Class     Attributes

  A           3x3                  72  double
  B           3x3                  72  double
  C           3x3                  72  double

>> %% Grand total is 27 using 216 bytes
```

Workspace

Name	Value
A	[9,8,7;6,5,4;3,2,1]
B	[18,17,16;15,14,13;
C	[27,25,23;21,19,17;

Command History

```
%-- 27-07-202...
A = [9 8 7;6 ...
B = [18 17 16...
C = A + B
whos
```

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Current Folder

Name

Details

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Command Window

```
    27    25    23
    21    19    17
    15    13    11

>> whos
  Name      Size              Bytes  Class     Attributes

  A         3x3                  72  double
  B         3x3                  72  double
  C         3x3                  72  double

>> %% Grand total is 27 using 216 bytes
>> A*B

ans =

   366   342   318
   231   216   201
    96    90    84

>> F = inv(A)
Warning: Matrix is close to singular or badly scaled. Results
may be inaccurate. RCOND =  3.083953e-18.


F =

   1.0e+15 *

    2.2518   -4.5036    2.2518
   -4.5036    9.0072   -4.5036
    2.2518   -4.5036    2.2518

fx >>
```

Workspace

Name	Value
A	[9,8,7;6,5,4;3,2,1]
ans	[366,342,318;231,2
B	[18,17,16;15,14,13;
C	[27,25,23;21,19,17;
F	[2.2518e+15,-4.50

Command History

```
%-- 27-07-202...
A = [9 8 7;6 ...
B = [18 17 16...
C = A + B
whos
%% Grand tota...
A*B
F = inv(A)
```

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Current Folder

Name

Details

Select a file to view details

Command Window

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

A =

     9     8     7
     6     5     4
     3     2     1

>> A'

ans =

     9     6     3
     8     5     2
     7     4     1

>> A^2

ans =

   150   126   102
    96    81    66
    42    36    30

>> A.^2

ans =

    81    64    49
    36    25    16
     9     4     1

fx >>
```

Workspace

Name	Value
A	[9,8,7;6,5,4;3,2,1]
ans	[81,64,49;36,25,16;
B	[18,17,16;15,14,13;
C	[27,25,23;21,19,17;
F	[2.2518e+15,-4.50

Command History

```
%-- 27-07-202...
A = [9 8 7;6 ...
B = [18 17 16...
C = A + B
whos
%% Grand tota...
A*B
F = inv(A)
clc
A = [9 8 7;6 ...
A'
A^2
A.^2
```

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Command Window

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

ans =

     8     7
     5     4

>> [rank(A) det(A)]

ans =

    2.0000   -0.0000

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

V =

   -0.8187   -0.6123    0.4082
   -0.5253    0.0868   -0.8165
   -0.2320    0.7858    0.4082


D =

   16.1168         0         0
         0   -1.1168         0
         0         0   -0.0000

>>
```

Workspace

Name	Value
A	[9,8,7;6,5,4;3,2,1]
ans	[2,-1.3323e-15]
B	[18,17,16;15,14,13;
C	[27,25,23;21,19,17;
D	[16.1168,0,0;0,-1.1
F	[2.2518e+15,-4.50
V	[-0.8187,-0.6123,0.

Command History

```
F = inv(A)
clc
A = [9 8 7;...
A'
A^2
A.^2
clc
A(4:5,6:8)          0.20 sec
clc
A(3:4,4:5)
clc
A(1:2,2:3)
[rank(A) de...
[V,D] = eig(A)
```

A short interactive session

```
>> A=[1 2 3;4 5 6;7 8 9];
>> for i=1:3
for j=1:3
if A(i,j) <= 5
A(i,j)=0;
end
end
end
>> A

A =

     0     0     0
     0     0     6
     7     8     9
```

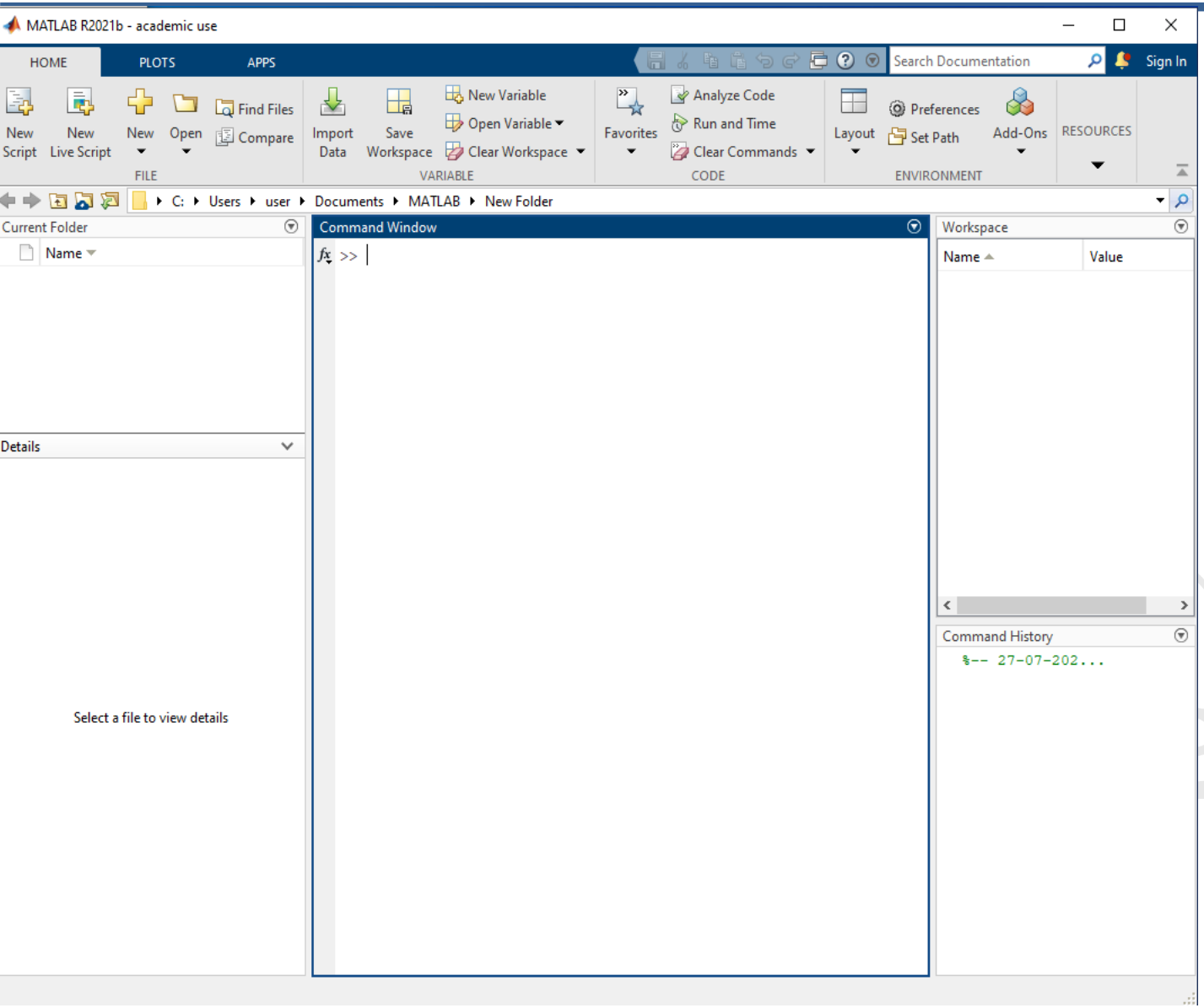
Another short interactive session

```
>> A=[1 2 3;4 5 6;7 8 9];
>> B=[ ];
>> for i=1:3
B=[B;A(i,:)'];
end
>> B

B =

   1
   2
   3
   4
   5
   6
   7
   8
   9
```

Writing M-Files

- Interactive Programming is useful only in the initial stages – when you are learning the syntax, commands etc.
- Very soon you should graduate into writing what are called m-files.
- M-files are text files that contain a sequence of MATLAB commands to achieve the required goals.
- You can enter the commands into a file and save it. Then just type in the file name inside the MATLAB command window. All the commands will be executed and the results will be available in the MATLAB workspace

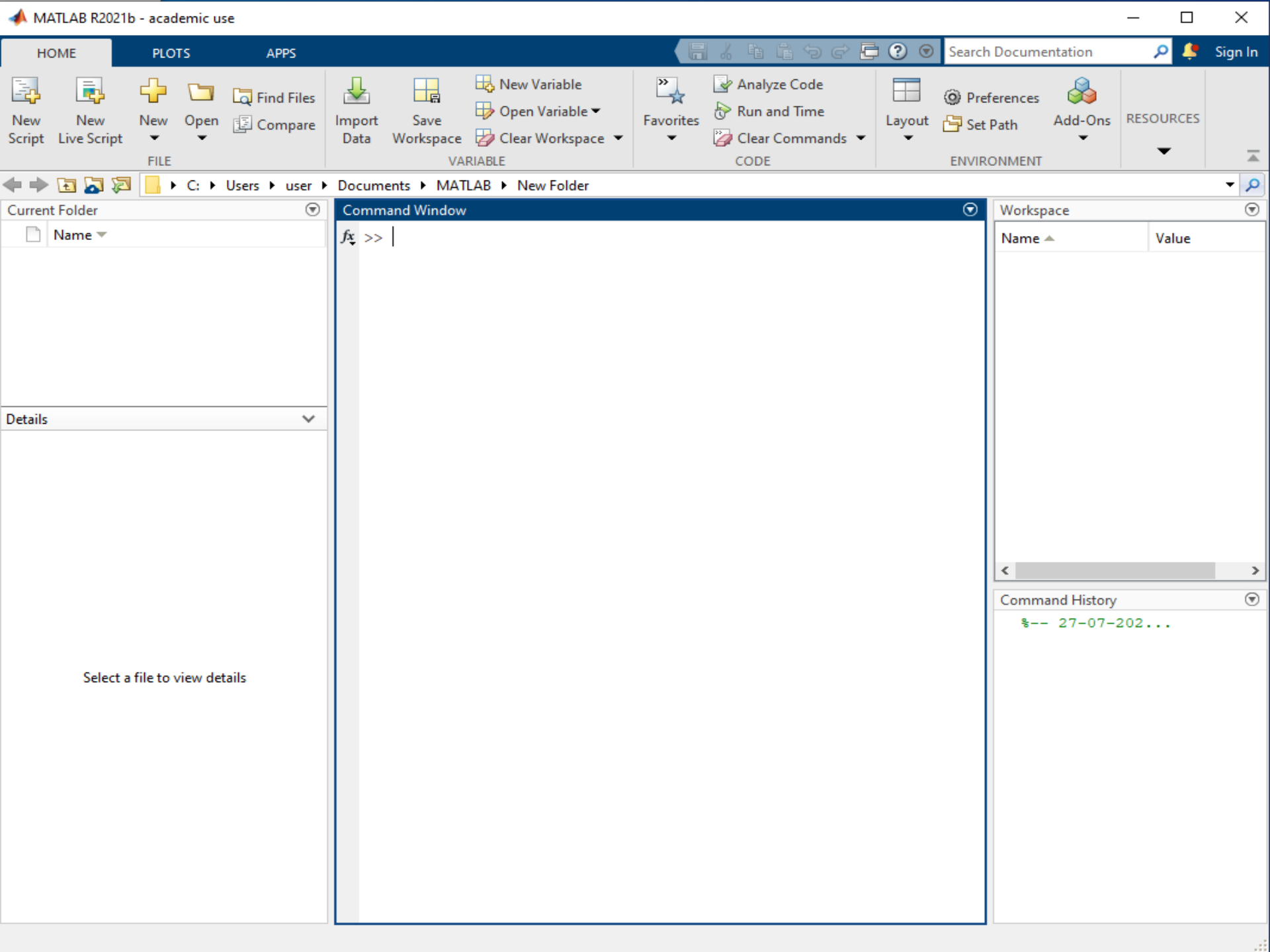
Writing M-Files



Choose

Files
↓
New
↓
M-file

This will open up a new window for entering the MATLAB commands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Select a file to view details
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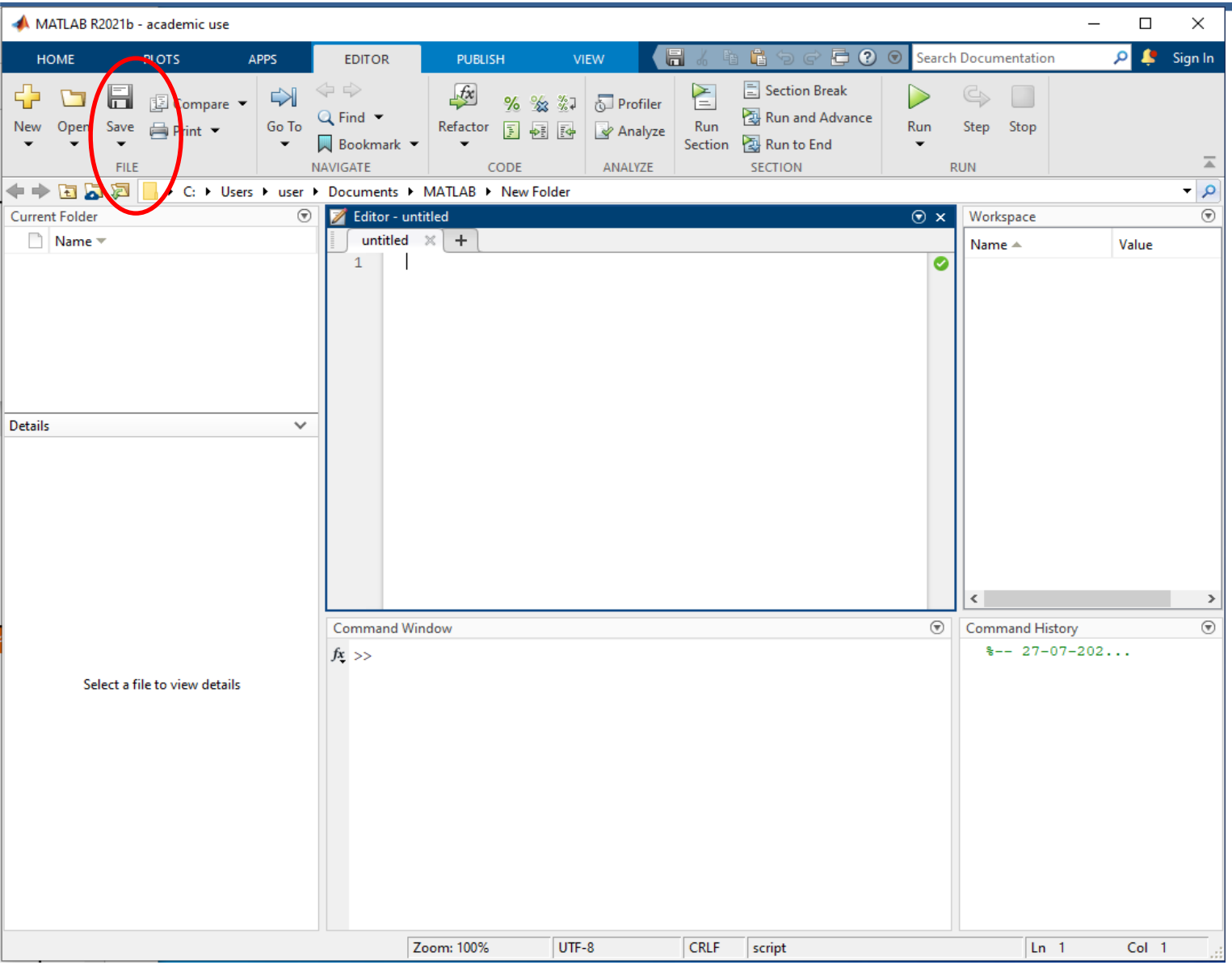
>>
Workspace
Name
Value
Command History
%-- 27-07-202...

Writing M-Files



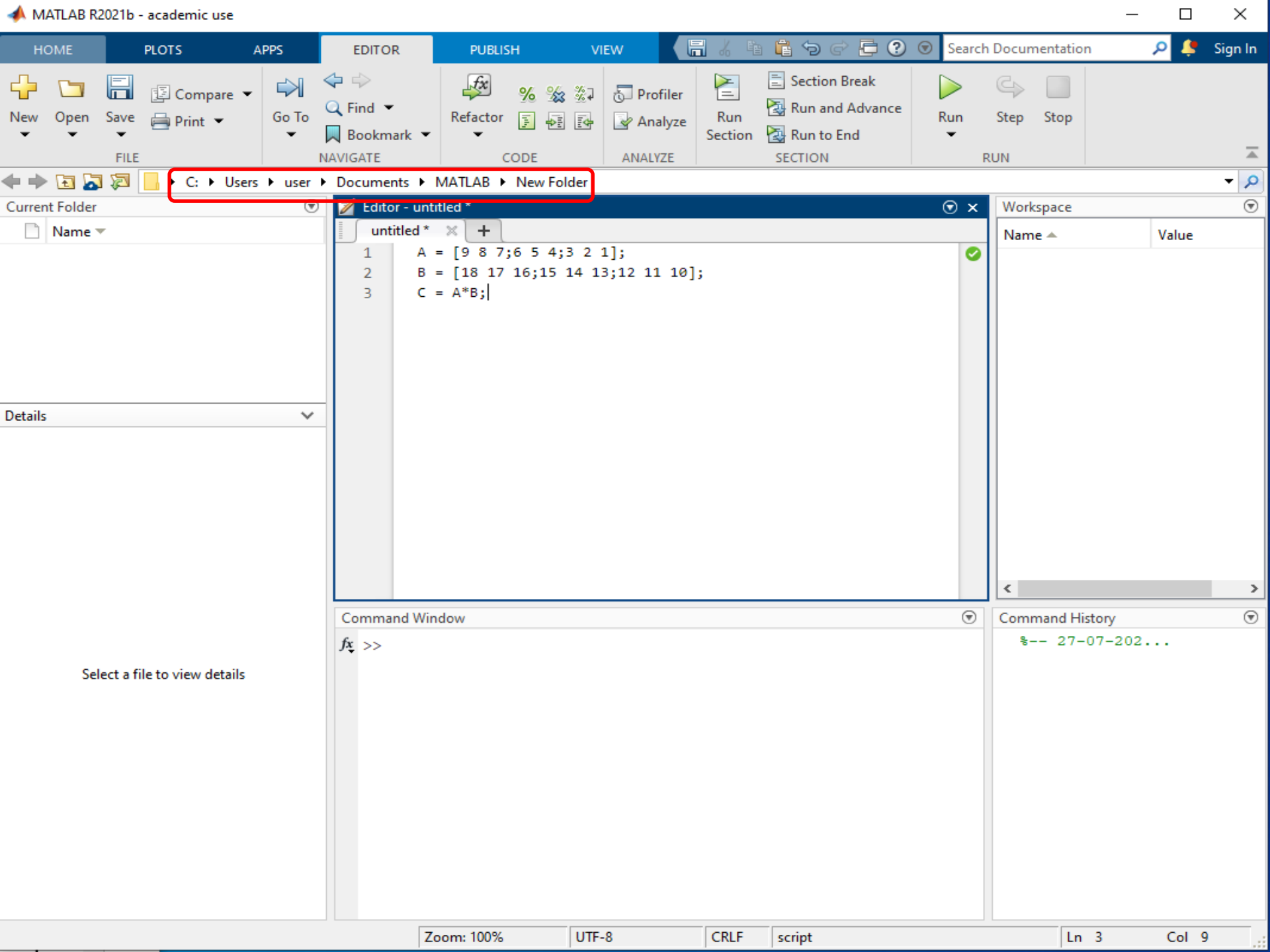
Choose

File

↓

Save

and specify the directory and a name for the file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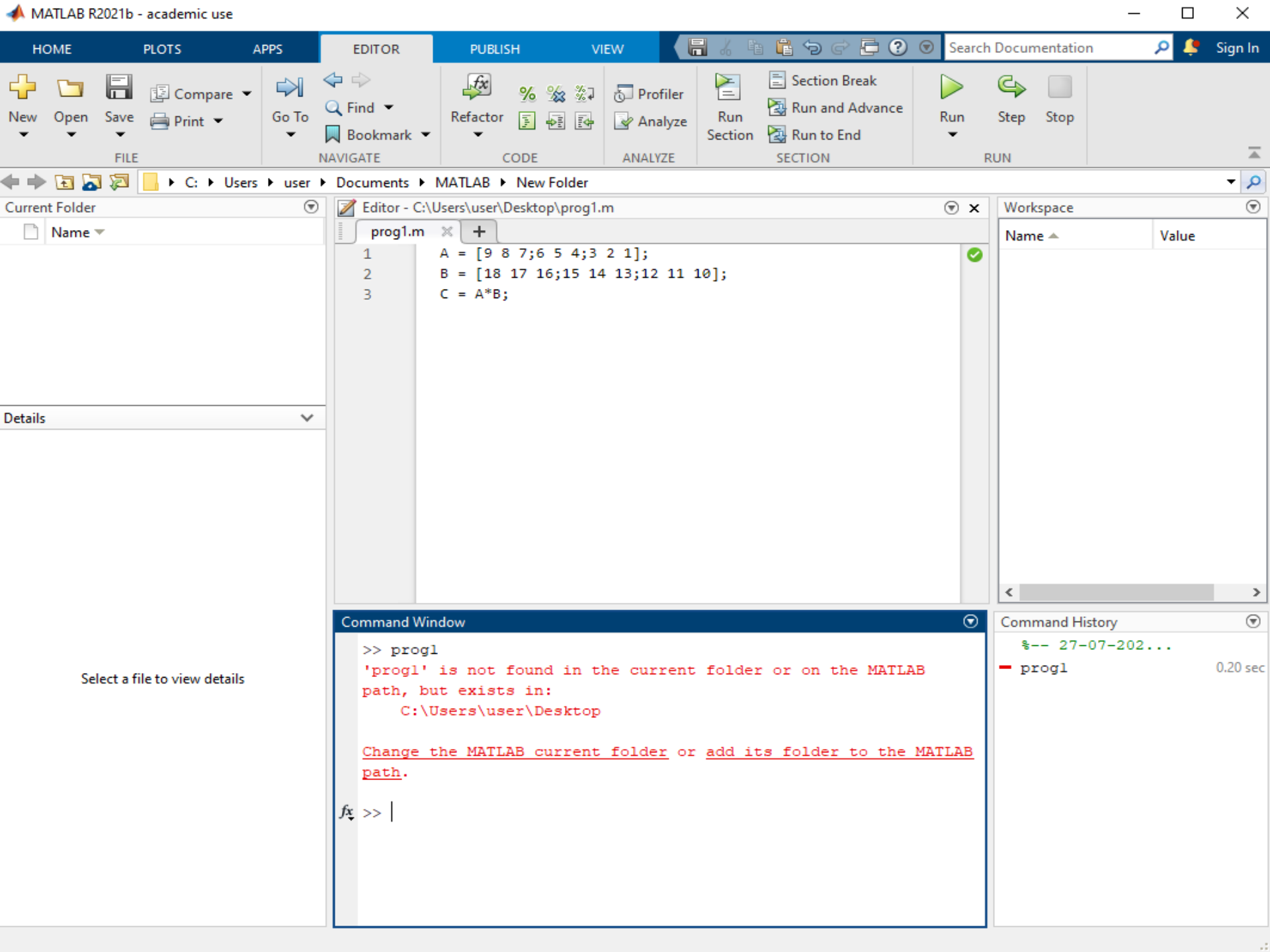
Analyze
ANALYZE
Run Section
Section Break
Run and Advance
Run to End
SECTION
Run
Step
Stop
RUN
C: ▸ Users ▸ user ▸ Documents ▸ MATLAB ▸ New Folder
Current Folder
Name
Details
Select a file to view details
Editor - untitled *
untitled *
1 A = [9 8 7;6 5 4;3 2 1];
2 B = [18 17 16;15 14 13;12 11 10];
3 C = A*B;
Workspace
Name
Value
Command Window
>>
Command History
%-- 27-07-202...
Zoom: 100%
UTF-8
CRLF
script
Ln 3
Col 9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Step
Stop
RUN
C: ▸ Users ▸ user ▸ Documents ▸ MATLAB ▸ New Folder
Current Folder
Name
Details
Select a file to view details
Editor - C:\Users\user\Desktop\prog1.m
prog1.m
1 A = [9 8 7;6 5 4;3 2 1];
2 B = [18 17 16;15 14 13;12 11 10];
3 C = A*B;
Workspace
Name
Value
Command Window
>> prog1
'prog1' is not found in the current folder or on the MATLAB path, but exists in:
C:\Users\user\Desktop
Change the MATLAB current folder or add its folder to the MATLAB path.
>>
Command History
%-- 27-07-202...
prog1
0.20 sec

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Run Step Stop RUN

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Current Folder

Name

Details

Select a file to view details

Editor - C:\Users\user\Desktop\prog1.m

prog1.m

```
1  A = [9 8 7;6 5 4;3 2 1];
2  B = [18 17 16;15 14 13;12 11 10];
3  C = A*B;
```

Workspace

Name	Value
ans	'C:\Users\user\Do

Command Window

```
path, but exists in:
    C:\Users\user\Desktop

Change the MATLAB current folder or add its folder to the MATLA
path.

>> pwd

ans =

    'C:\Users\user\Documents\MATLAB\New Folder'

>>
```

Command History

```
%-- 27-07-202...
prog1                0.20 sec
pwd
```

matlab:matlab.internal.language.commandline.executeCode('cd ''C:\Users\user\Desktop''')