Introduction to MATLAB

1.1 What is MATLAB?
1.2 Matlab Desktop
1.3 Manipulating Data in Matlab

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DEI < lab />

What is MATLAB?

What is MATLAB?

- Matlab comes from “MATrix LABoratory”
- Programming Environment
  - Technical and Scientific Computation
    - Matrix and Vector Oriented
  - Visualization
  - High-level language
  - Toolboxes

What is MATLAB?

- Some toolboxes:
  - Optimization Toolbox
  - Image Processing Toolbox
  - Neural Network Toolbox
  - Non Linear Control Design Toolbox
  - Aeroespace Toolbox
  - Bioinformatics Toolbox
  - more…

MATLAB Desktop

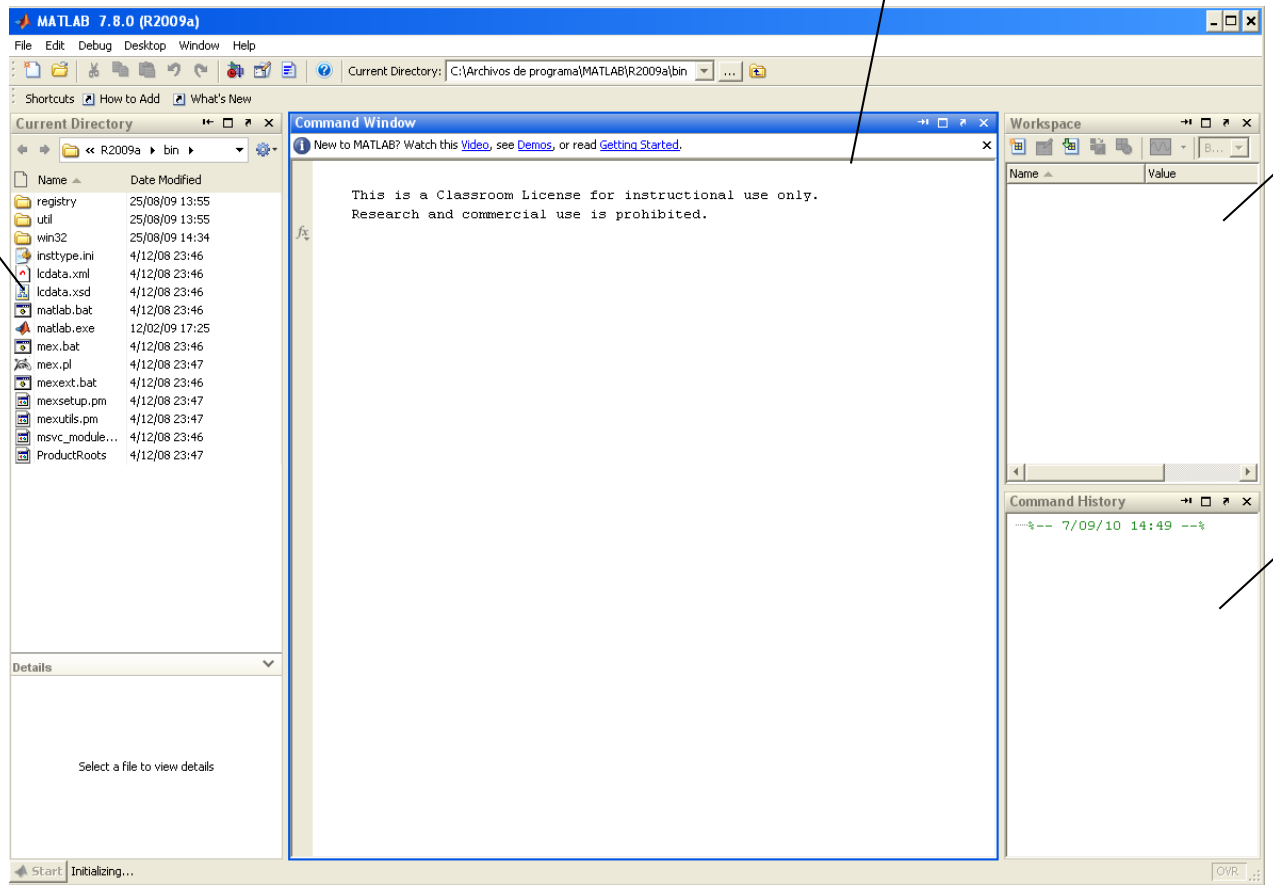
Desktop: Default Layout

Command Line

Current Folder

Workspace

Command History



Desktop: Default Layout

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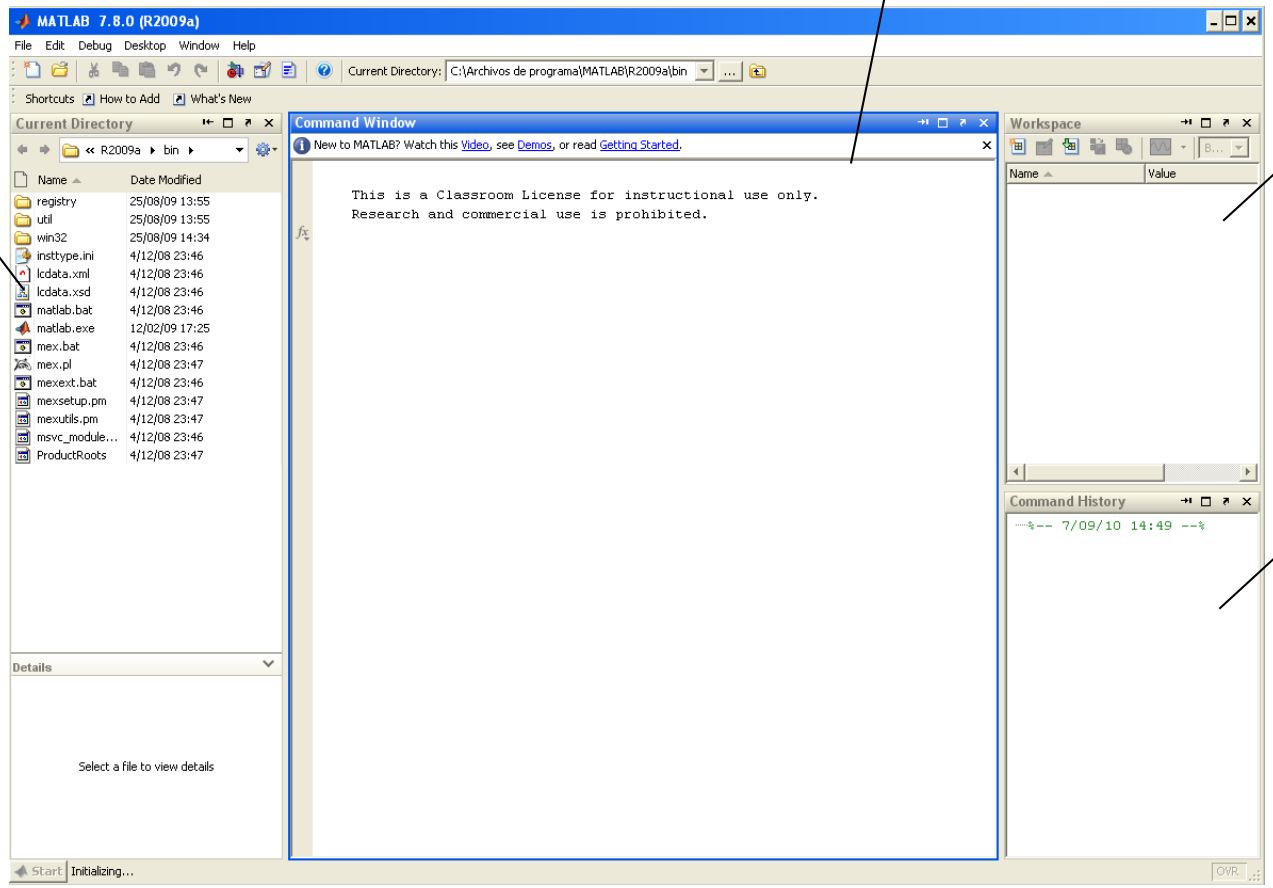

Desktop: Command Line Window

The command line window allows users to provide instructions to Matlab about “what to do”.

```
    This is a Classroom License for instructional use only.
    Research and commercial use is prohibited.
>>
```

- The >> symbol is called the **prompt**.
- To **enter** an instruction simply type it after the prompt and press return.

Desktop: Command Line Window

- You can use MATLAB as a calculator:

  >> 4 + 4

  ans = 8

- You can use predefined Math functions
  - abs, acos, angle, cos, asin, complex, floor, fix, mod,..

  >> cos(0)

  ans = 1

- You can visualize data:

  >> plot ([1:10])

- Other uses: read data from a file, write data, import data, create matrices…

Desktop: Command Line Window

Introduce data

Introduce commands

Command Window

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

```
    This is a Classroom License for instructional use only.
    Research and commercial use is prohibited.
>>
>> %-- 7/09/10 14:49 --
>> a = [ 1 2; 2 1 ]

a =

     1     2
     2     1

>> a*a

ans =

     5     4
     4     5

>>
```

Command Window: General Purpose Commands

- Commands
  - clc — Clean screen
  - clear — Remove items from the workspace
  - help — Display help for MATLAB funtions
  - lasterr — Last error message
  - lastwarn — Last warning message
  - ver — Version
  - path — Control MATLAB's directory search path
  - addpath — Add directories to MATLAB's search path
  - ..

Desktop: Default Layout

Command Line

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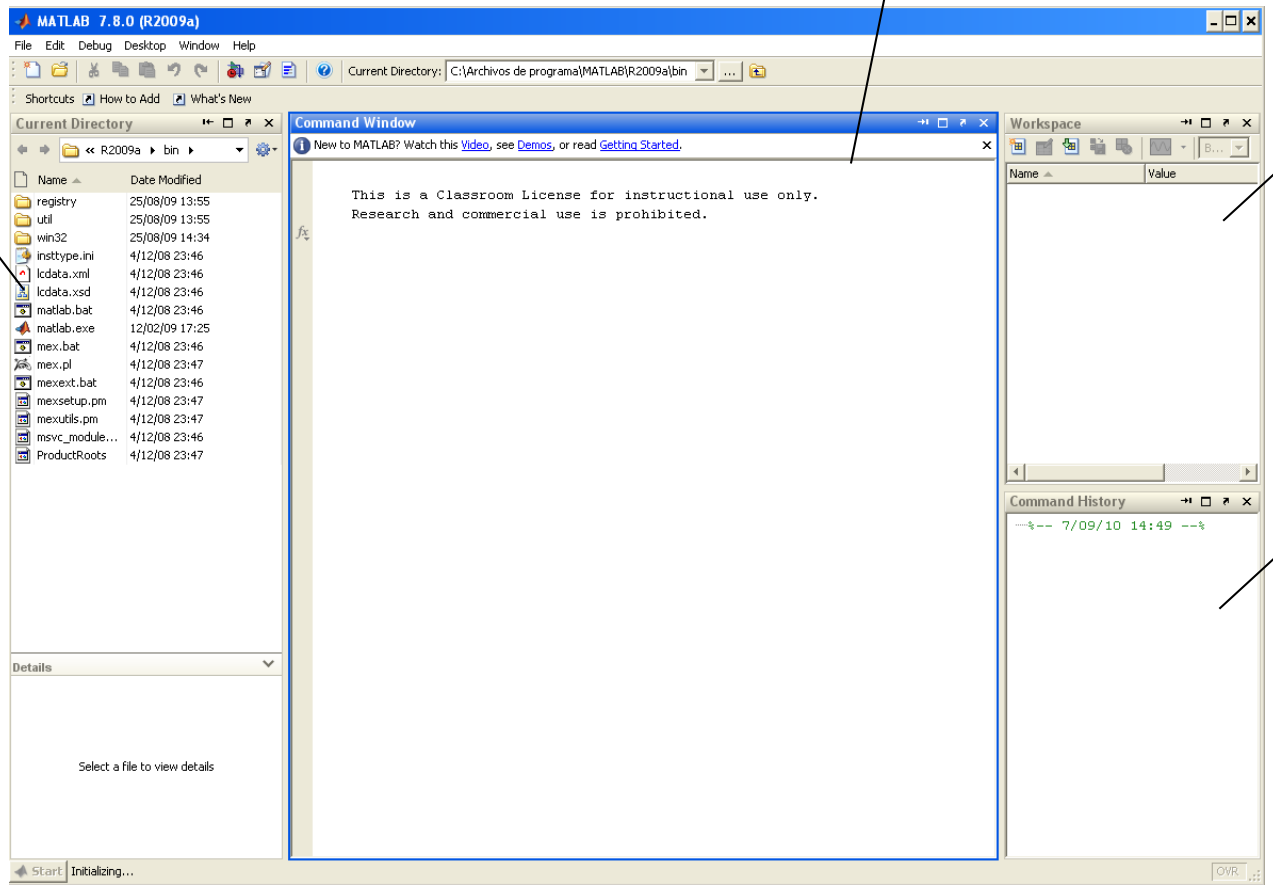
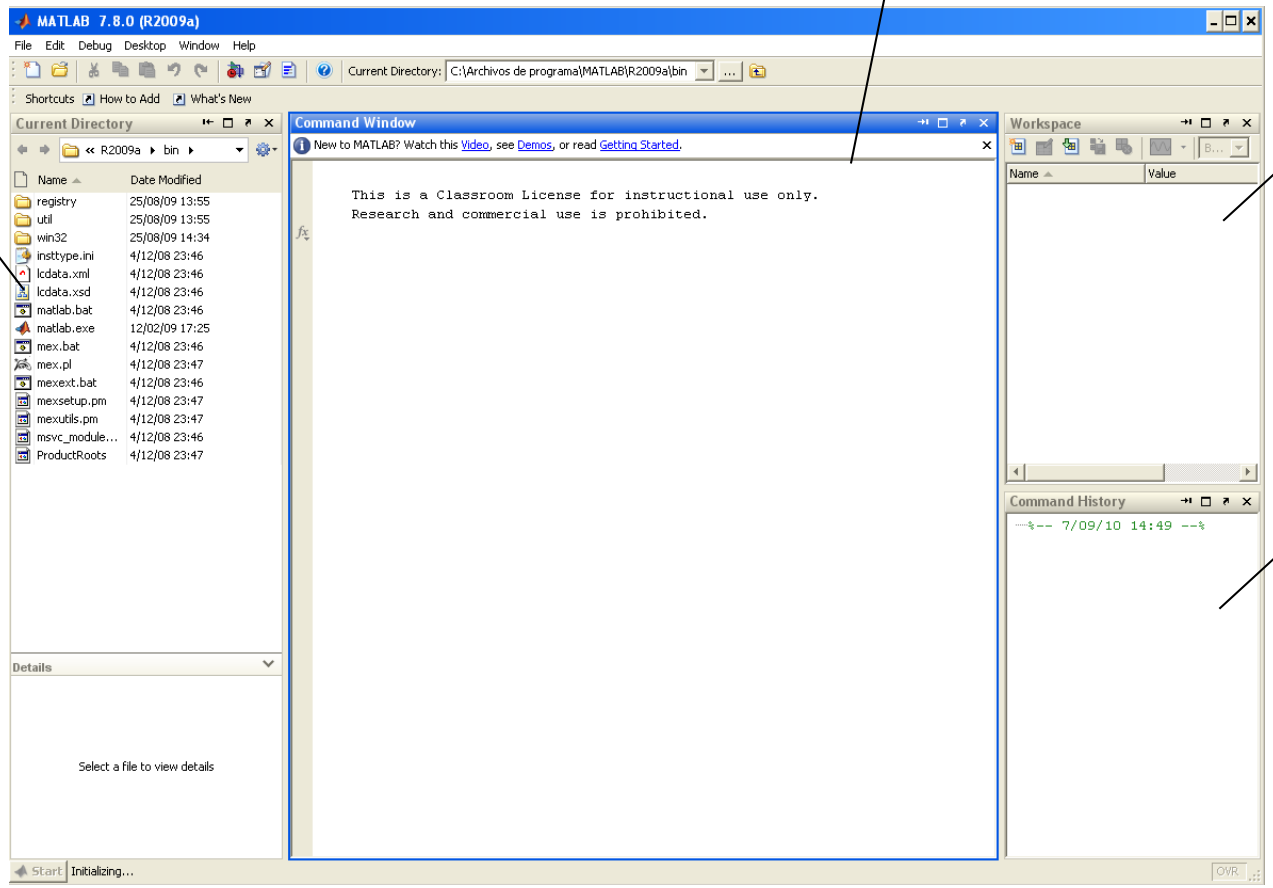
Command History



Desktop: Default Layout

Command Line

Current Folder

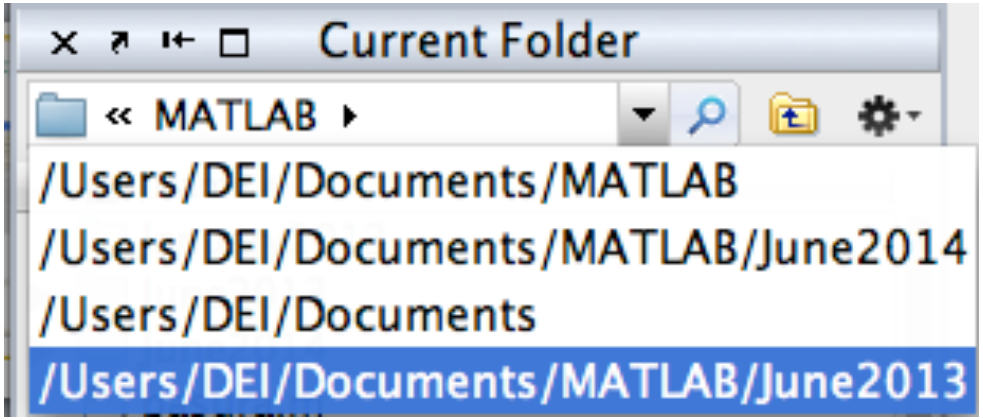


Workspace

Command History

Current Folder Window

- The current folder window shows the files in the current folder right now
- You can navigate through your folders the same way as you do it using the ‘explorer’ (windows) or ‘finder’ (mac)

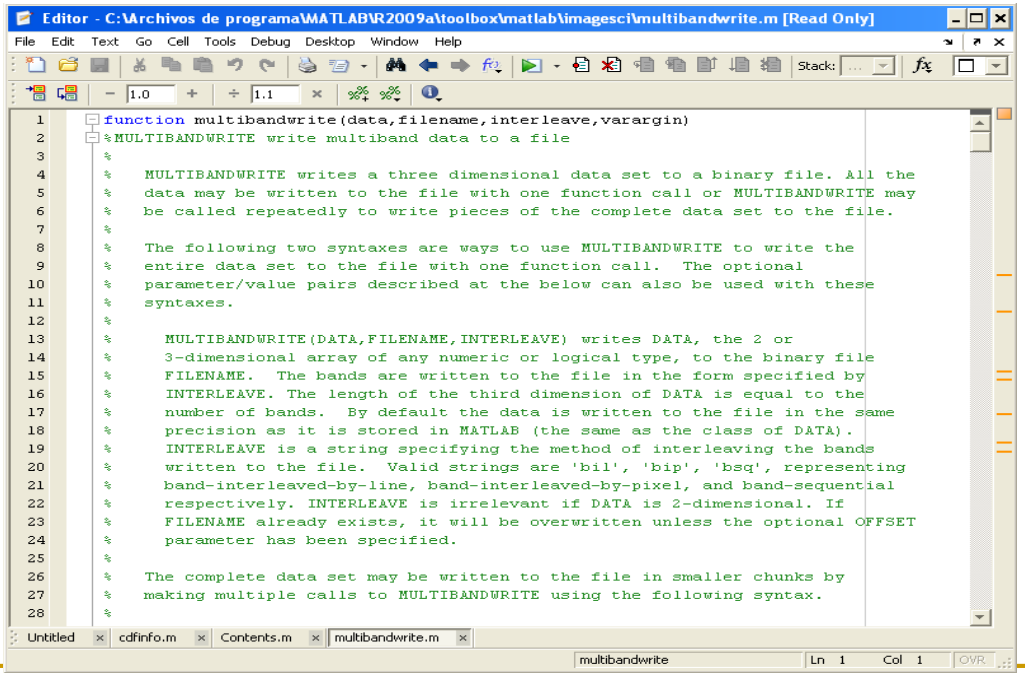


Current Folder Window

- It is important to get used to move around your hard drive using the current folder window
- **You should always know where your program files are, and which your current folder is**
  - It is a common mistake for beginners to not be able to find their programs in the computer.

Desktop: Editor

- Provides a graphical user interface for editing programs (M-files) and for debugging their execution



Desktop: Editor

- Users can wrap up a sequence of commands and save then into a file for later execution
- Those command files are called **M-files** as they use the extension *.m*
- **M-files** are simply text files. They can be written and read using standard text editors (Microsoft Word is not valid) or MATLAB specific editor

Desktop: Editor

- You can open the editor
  - Typing in the command line the command

    edit programname.m
  - *Using the menu File -> New -> Script*
  - *Click on the new script icon on the toolbar* 
  - *Click on the name of a program in the Current Folder Window*

Desktop: Editor

- Program example
  - Type the following code in your MATLAB editor

```
disp('Hello!');
age = input ('How old are you? ');
maxBirthYear = 2020 - age;
minBirthYear = 2020 - age - 1;
fprintf('\n Then you were born in %d or in %d', maxBirthYear,
   minBirthYear);
```

  - Save the program with the name `myProgram.m`
    - By default Matlab will save the program with extension .m

Desktop: Editor

- To execute the program
  - From the Editor window: click on the symbol 
  - From the command window: type

    run myProgram

MATLAB will look for your program in your 'current folder'

Desktop: Editor

- To execute the program
  - From the Editor window: click on the symbol 
  - From the command window: type

    ```
    run myProgram
    ```

  - From the current directory window: drag the name of the program from the current directory window and drop it in the command window

Desktop: Editor

- Result of the execution

>> run myProgram

Hello!

How old are you? 18

Then you were born in 2001 or in 2000

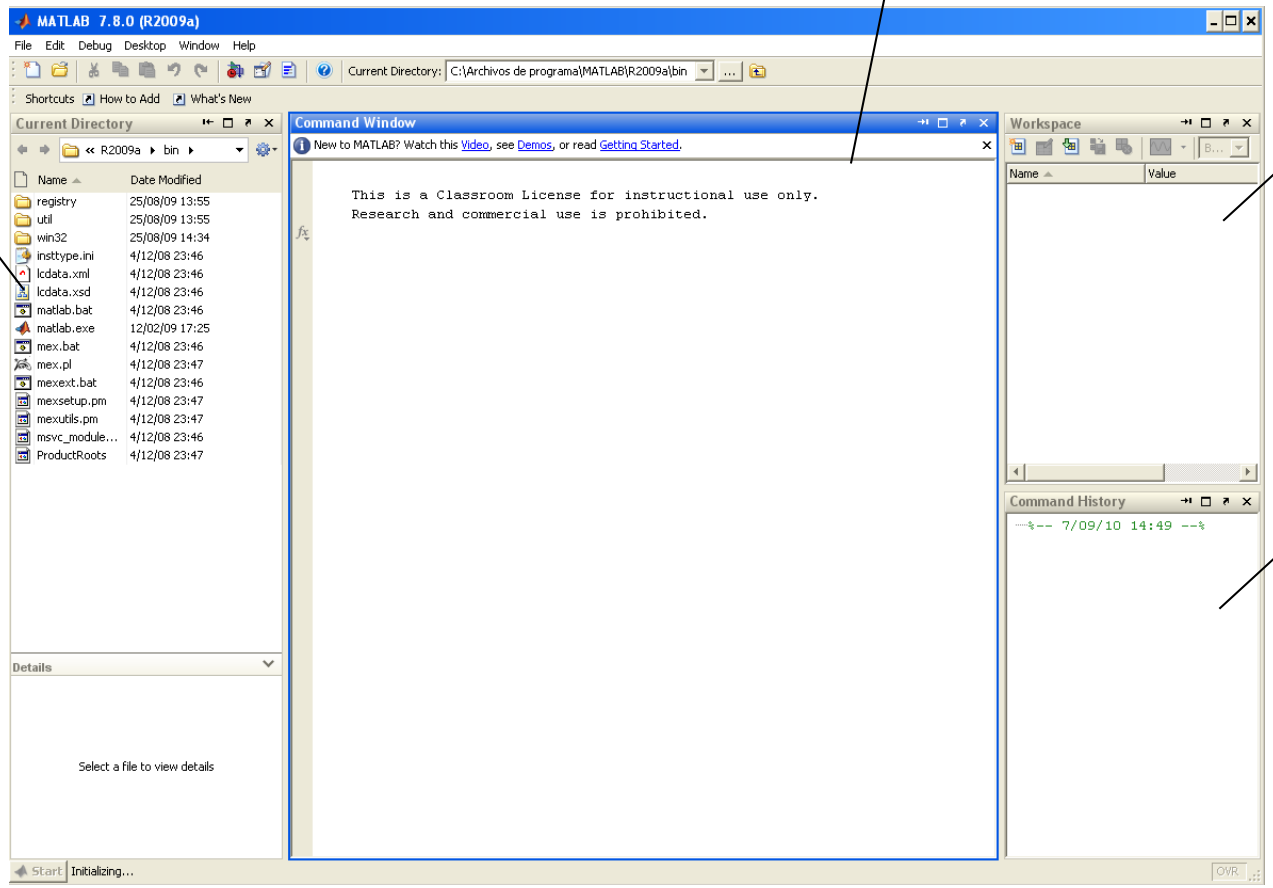
Desktop: Default Layout

Command Line

Current Folder

Workspace

Command History



Desktop: Default Layout

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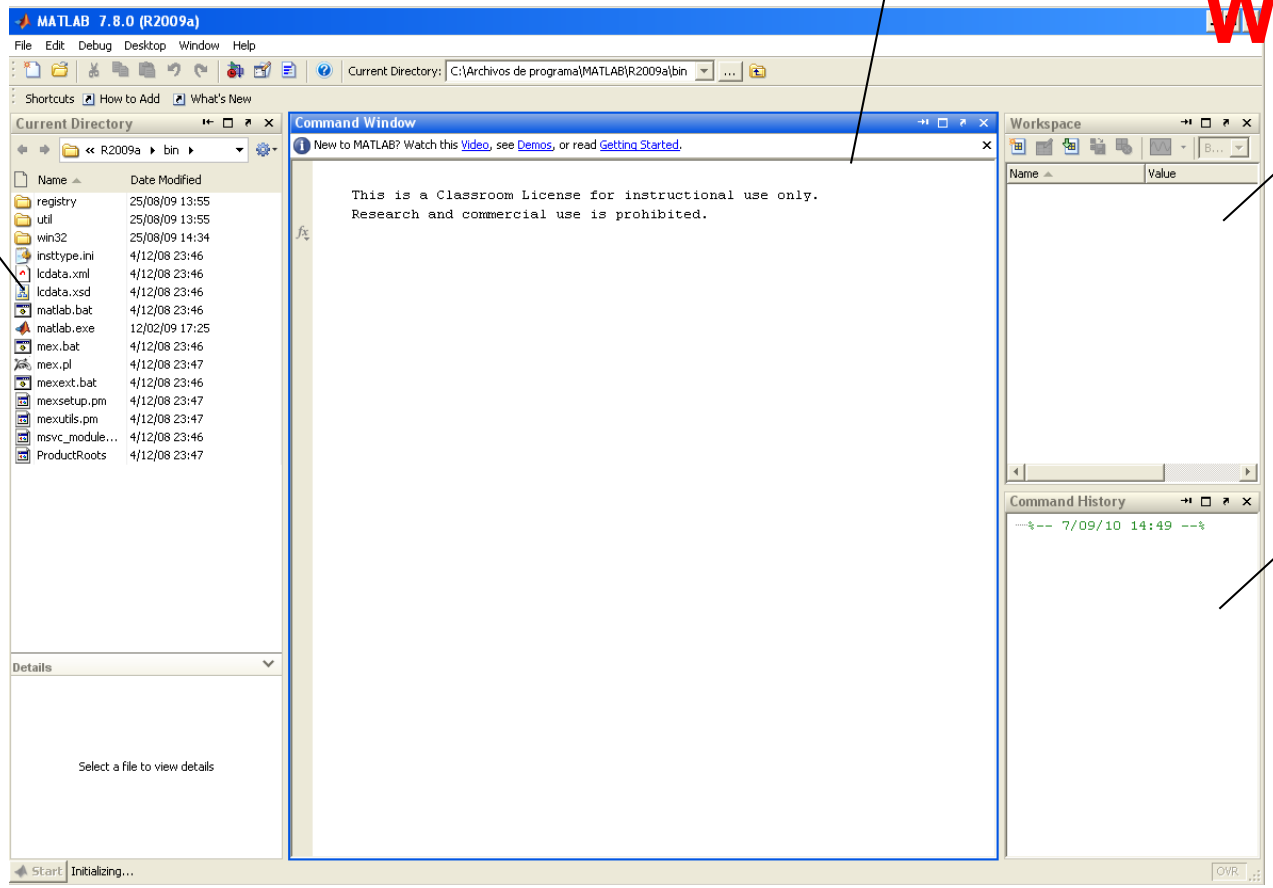
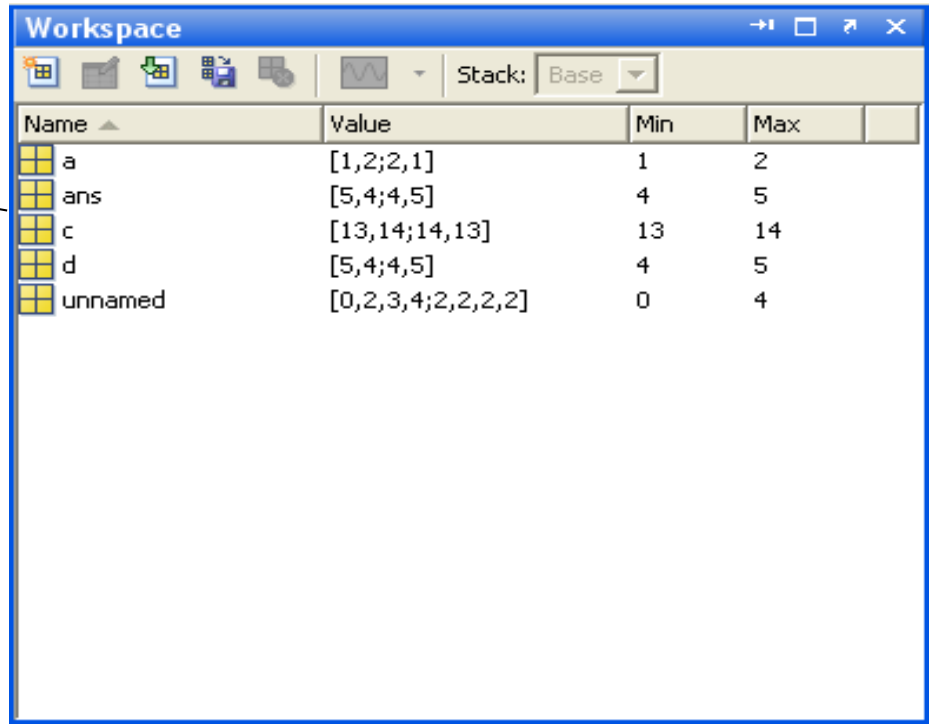


Command History

Desktop: Workspace Browser

- The Workspace Browser provide access to the variables built up during a Matlab session.

Double click on the variable name to change its data



Desktop: Workspace Browser

- Examples

>> 4 + 4

ans = 8 → The variable 'ans' is stored in the workspace with the value 8

*>> 10 * 2*

ans = 20 → Now the value of the variable 'ans' is updated to 20

*>> a = 20 * 5*

a = 100 → This time the result of the operation will be stored in the workspace in a variable called 'a'

*>> b = a * 100* → You can create as many variables in the workspace as you want

b = 2000

Desktop: Workspace Browser

- Note that…
  - Variables defined in a M file are added to the workspace, in the same way as when they are created from the command window

Manipulating data in Matlab: **Matrices**

Define and Manipulate Data

- Everything in Matlab is a Matrix
  - To create…
    - a Vector → A = [1 2 3]
    - a Matrix → B = [1 2 3; 4 5 6; 7 8 9]
    - a Matrix → B = [1 2 3
      4 5 6
      7 8 9]

Semicolons and newlines separate **rows**

Spaces and commas separate **columns**

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To access…
    - an element of a vector: *vector_name(position)*
    - an element of a matrix: *matrix_name(row, column)*
    - a entire row of a matrix: *matrix_name(row, :)*
    - a entire column of a matrix: *matrix_name(:, column)*
    - a part of the matrix B(row_ini:row_end , col_ini:col_end)

>>A(2)	>> B(2,2)	>>B(1,:)	>>B(1:2,2:3)
ans = 2	ans = 5	ans = [1 2 3]	ans = [2 3; 5 6]
The element in the 2nd position of the vector	The element in the second row and second column of the matrix	The first row	The range of values between the first row and second column and the element in the second row and secon column

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To access…
    - an element of a vector: *vector_name(position)*
    - an element of a matrix: *matrix_name(row, column)*
    - a entire row of a matrix: *matrix_name(row, :)*
    - a entire column of a matrix: *matrix_name(:, column)*
    - a part of the matrix B(row_ini:row_end , col_ini:col_end)

What happen when you try to access a position out of the range of the Vector/Matrix?

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To access…
    - an element of a vector: *vector_name(position)*
    - an element of a matrix: *matrix_name(row, column)*
    - a entire row of a matrix: *matrix_name(row, :)*
    - a entire column of a matrix: *matrix_name(:, column)*
    - a part of the matrix B(row_ini:row_end , col_ini:col_end)

What happen when you try to access a position out of the range of the Vector/Matrix?
Error: Index exceeds matrix dimensions.

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To modify …
    - an element of a vector *vector_name(position) = new value*
    - an element of a matrix *matrix_name(row, column) = new value*

```
>> A = [1 2 3]
A =   1 2 3
>> A(2) = 4
A =   1 4 3
```

```
>> B = [1 2 3; 4 5 6]
B =   1 2 3
      4 5 6
>> B(2,2) = 6
B =   1 2 3
      4 6 6
```

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To modify …
    - an element of a vector *vector_name(position) = new value*
    - an element of a matrix *matrix_name(row, column) = new value*

What happen when you try to assign a value to a position out of the range? Example B(1,4) = 5

```
>> B = [1 2 3; 4 5 6]
B =   1 2 3
      4 5 6
>> B(2,2) = 6
B =   1 2 3
      4 6 6
```

Define and Manipulate Data

- Everything in Matlab is a Matrix

A

1	2	3

B

1	2	3
4	5	6

  - To modify …
    - an element of a vector *vector_name(position) = new value*
    - an element of a matrix *matrix_name(row, column) = new value*

What happen when you try to assign a value to a position out of the range? Example B(1,4) = 5
Matlab fill the rest of the matrix with zeros

```
>> B = [1 2 3; 4 5 6]
B =   1 2 3
      4 5 6
>> B(2,2) = 6
B =   1 2 3 5
      4 6 6 0
```

Define and Manipulate Data

- Everything in Matlab is a Matrix
  - To delete an element:
    - Matlab deletes an element and reorganizes the matrix/vector
    - Delete an element of a vector: *vector_name (position) = [ ];*
    - Delete the row of a matrix: *matrix_name (row, :) = [ ];*
    - Delete the column of a matrix: *matrix_name (:, column) = [ ];*
    - Example:

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

```
>> B = [1 2 3; 4 5 6];
>> B(:,2) = [ ];
>> B
B = [1 3
     4 6]
```

Define and Manipulate Data

- Everything in Matlab is a Matrix
  - Specials function to define vectors and matrices: *zeros, ones*
    - zeros(number of rows, number of columns)
    - Example:

```
A = zeros(2,2)
A = [0 0
     0  0]
```

    - ones(number of rows, number of columns)
    - Example:

```
A = ones(1,3)
A = [1 1  1]
```

These two functions are very useful to give an initial value to all the elements in a matrix or vector

Define and Manipulate Data

- Everything in Matlab is a Matrix
  - size (*matrix*) returns the size of the matrix
    - Example:

```
size(A)
ans = 2    2
```

This means that the matrix A has 2 rows and 2 columns

Aritmetic Operators

- Aritmetic operators
  - + Matrix Addition
  - - Matrix Subtraction
  - * Matrix multiplication
  - / Matrix right division
  - \ Matrix left division
  - ^ Matrix power
  - ‘ Matrix transpose

  - .* Array multiplication
  - ./ Array right division
  - .\ Array left division
  - .^ Array power
  - .‘ Array transpose

- Matrix arithmetic operations are defined by the rules of linear algebra.

- Array arithmetic operations are carried out element by element

Other Operators

This is a very important operator you are going to use very often in this course

- :
  - It generates a sequence of values
  - Usefull to create matrices and vectors
  - Use:

    initial value **:** *step* : *final value*

    OR

    initial value : final value
  - Examples:
    - A = 4:7
      A = [4 5 6 7]
    - B = 1:2:10
      B = [1 3 5 7 9]
    - C = 4 : 0.1: 4.5
      C = [4 4.1 4.2 4.3 4.4 4.5]
    - D = 4: -1: 0
      D = [4 3 2 1 0]

Bibliography

- “MATLAB: An introduction with Applications”, John Wiley & Sons, Inc., Hoboken (NJ), USA