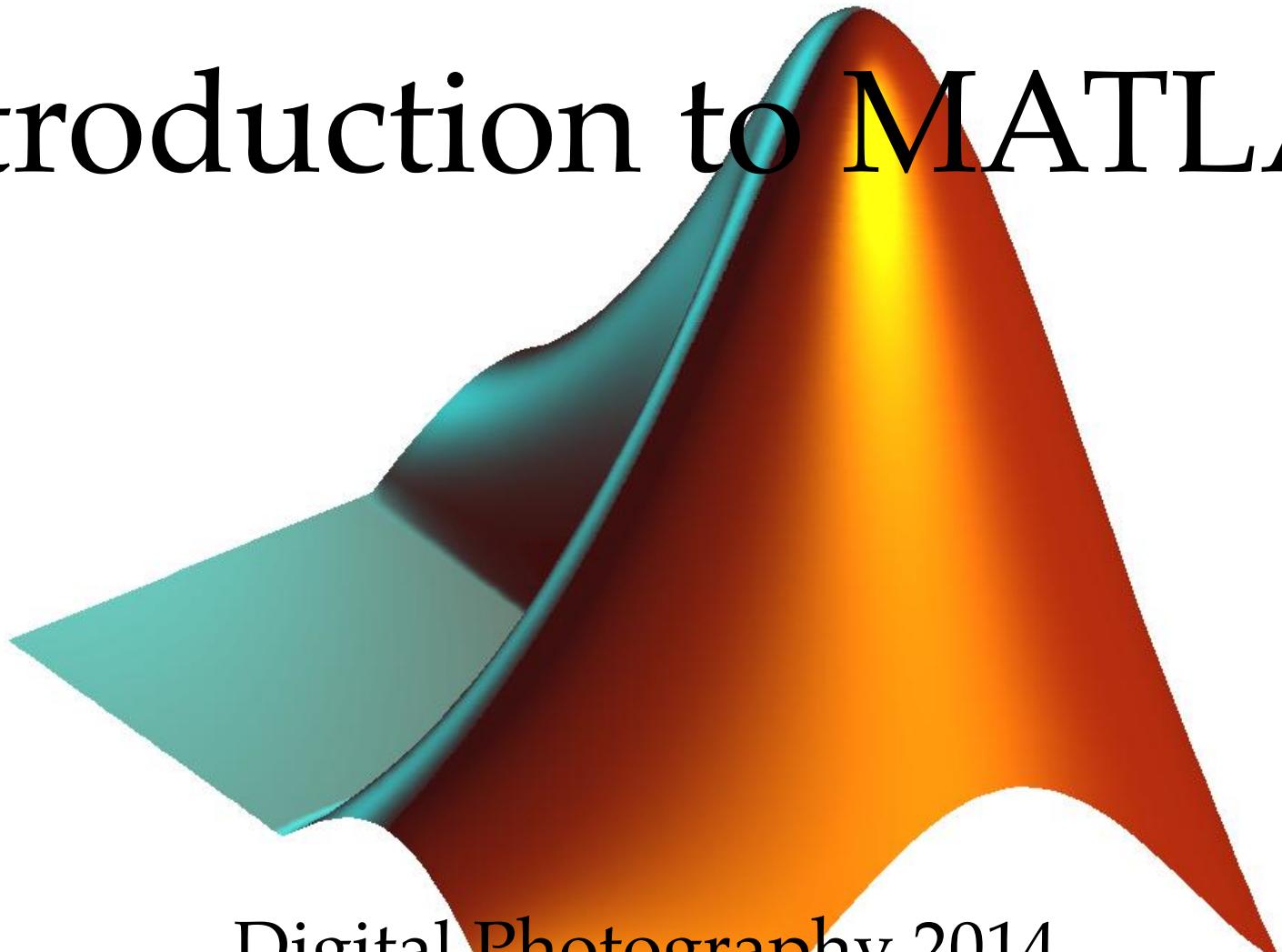
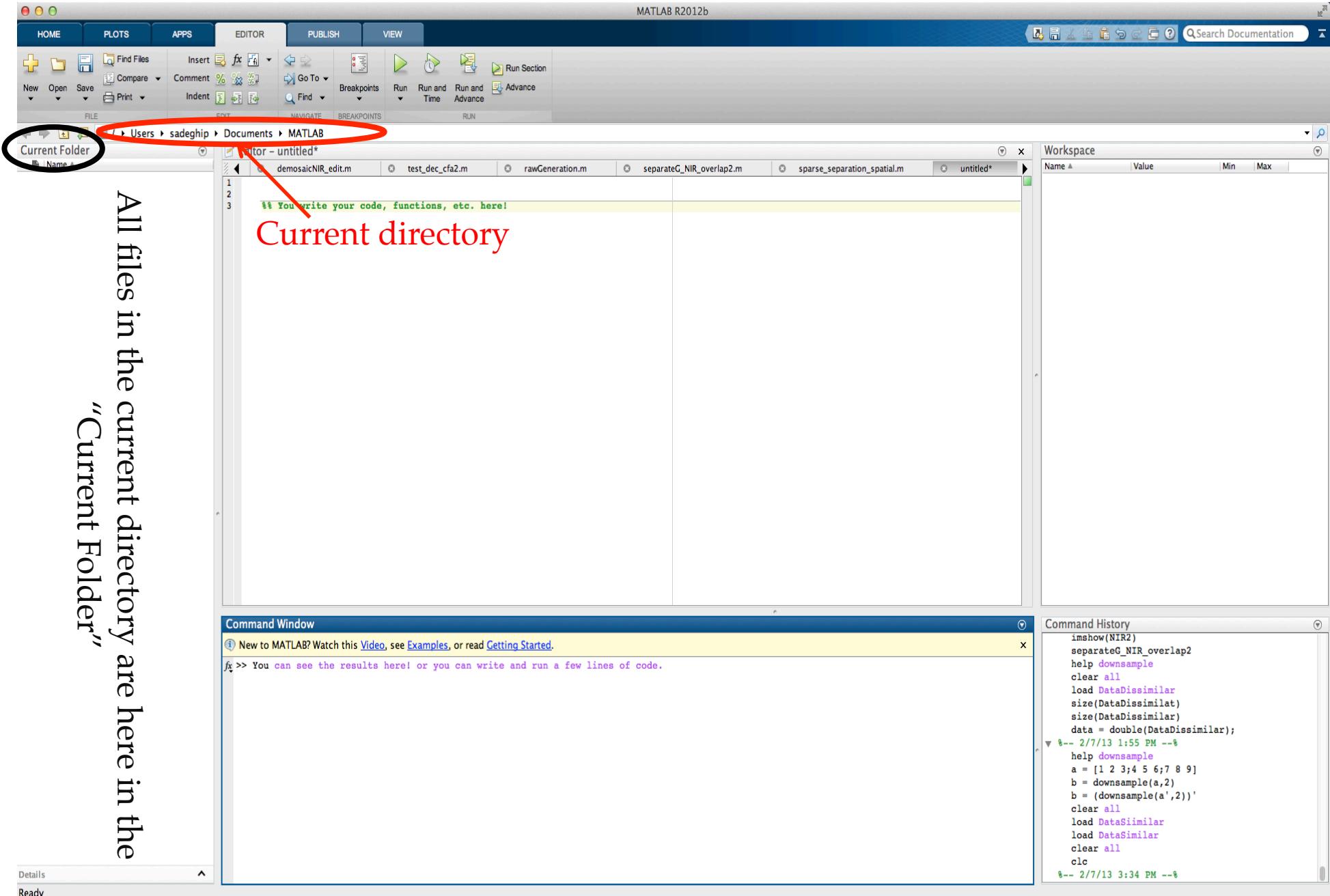


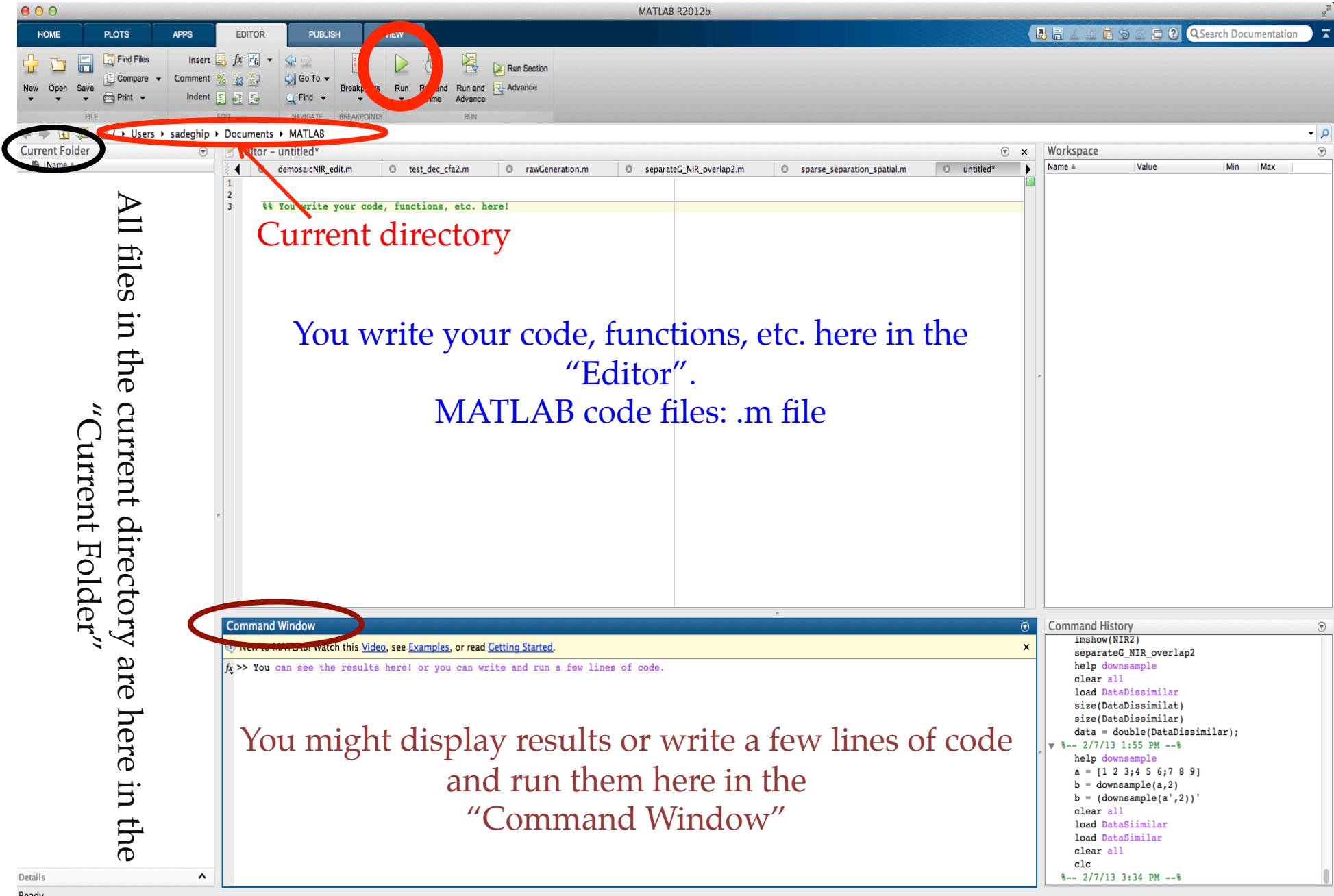
Introduction to MATLAB

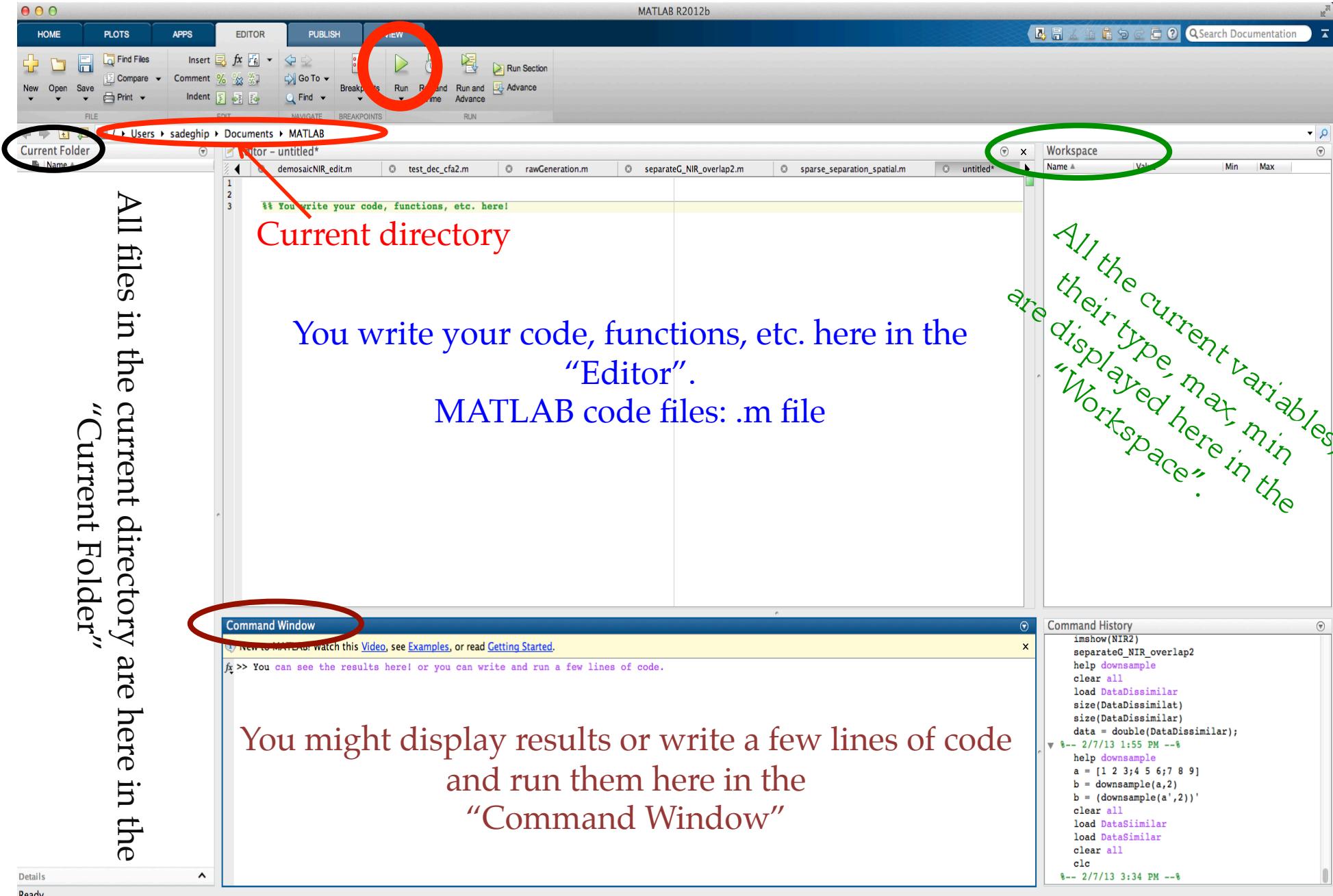


Digital Photography 2014
IVRG-IC-EPFL
Zahra Sadeghipoor



All files in the current directory are here in the
"Current Folder"





Data Types

- NO type definition! -> ~~int a=0;~~
- Integer, double, string, etc.

Matrices in MATLAB

- Create a matrix.

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

Let's go to MATLAB

Matrices in MATLAB

- Create a matrix.
 - MATLAB syntax: $A = [1,2,3;4,5,6;7,8,9];$
 - , → to separate columns
 - ; → new row in matrix
 - ; → also suppresses printing in the Command Window

Matrices in MATLAB

- Access elements, rows, and columns:
 - Element (i,j)
 - i^{th} row
 - j^{th} column
 - Columns 1 to 3
 - Rows 2 to the end
 - etc.

Let's go to MATLAB

Matrices in MATLAB

- Access elements, rows, and columns:
(MATLAB syntax)
 - Element (i,j): $A(i,j)$
 - ith row: $A(i,:)$
 - jth column: $A(:,j)$
 - Columns 1 to 3: $A(:,1:3)$
 - Rows 2 to the end: $A(2:end,:)$
 - etc.

Matrices in MATLAB

- Create a matrix.
 - zeros, eye, ones, random matrices, etc.

`zeros(2,3)`

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

`eye(3)`

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

`ones(4,2)`

$$\begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 1 & 1 \\ 1 & 1 \end{bmatrix}$$

Matrices in MATLAB

- Create a matrix.
- Matrix info.
 - Size, rank, determinant.

Matrices in MATLAB

- Create a matrix.
- Matrix info.
 - Size, rank, determinant.
- Matrix operations:
 - Sum, subtraction, multiplication.
 - Inverse.
 - Element-wise operations.
 - Search for an element.
 - etc.

Let's go to MATLAB

Matrices in MATLAB

- Assignment:

Write a simple code that solves the following set of equations:

$$2x_1 + 4x_2 + x_3 = 3$$

$$6x_1 + x_2 - 5x_3 = -4$$

$$-x_1 - 2x_2 + 9x_3 = 27$$

Let's go to MATLAB

Matrices in MATLAB

- Assignment:

Solution

$$2x_1 + 4x_2 + x_3 = 3$$

$$6x_1 + x_2 - 5x_3 = -4$$

$$-x_1 - 2x_2 + 9x_3 = 27$$



$$\mathbf{A} = \begin{bmatrix} 2 & 4 & 1 \\ 6 & 1 & -5 \\ -1 & -2 & 9 \end{bmatrix}, \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 3 \\ -4 \\ 27 \end{bmatrix}$$

Matrices in MATLAB

- Assignment:

Solution

$$\mathbf{A} = \begin{bmatrix} 2 & 4 & 1 \\ 6 & 1 & -5 \\ -1 & -2 & 9 \end{bmatrix}, \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 3 \\ -4 \\ 27 \end{bmatrix}$$



$$\mathbf{Ax} = \mathbf{b}$$

$$\mathbf{x} = \mathbf{A}^{-1}\mathbf{b}$$

Matrices in MATLAB

- Assignment:
Solution (MATLAB syntax)

$$A = \begin{bmatrix} 2 & 4 & 1 \\ 6 & 1 & -5 \\ -1 & -2 & 9 \end{bmatrix}, \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 3 \\ -4 \\ 27 \end{bmatrix} \rightarrow A = [2,4,1;6,1,-5;-1,-2,9];$$
$$b = [3;-4;27];$$

$$Ax = b \quad x = \text{inv}(A) * b;$$

→ or

$$\mathbf{x} = A^{-1}\mathbf{b} \quad x = A^{-1} * b;$$

Matrix Multiplication Instead of Loops

- Example:

$$\mathbf{a} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

- Compute:

$$\sum_{i=1}^3 a_i b_i$$

Matrix Multiplication Instead of Loops

- Example:

$$\mathbf{a} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

- Compute:

$$\sum_{i=1}^3 a_i b_i = \mathbf{a}^T \mathbf{b}$$

Matrix Multiplication Instead of Loops

- Example:

$$\mathbf{a} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

- Compute:

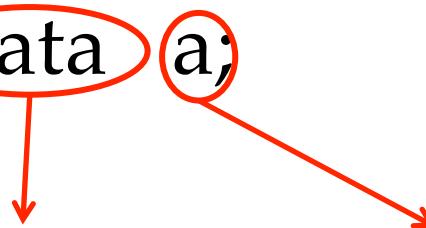
$$\sum_{i=1}^3 a_i b_i = \mathbf{a}^T \mathbf{b}$$

MATLAB syntax: $\mathbf{a}' * \mathbf{b}$

Save and Load Matrices

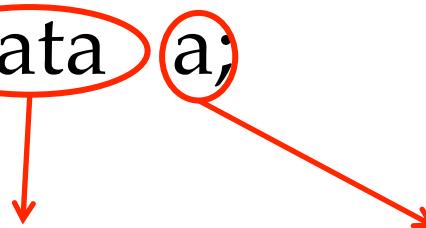
- save data a;

Save and Load Matrices

- save `data` `a;`

name of the file (.mat) name of the matrix to be saved

Save and Load Matrices

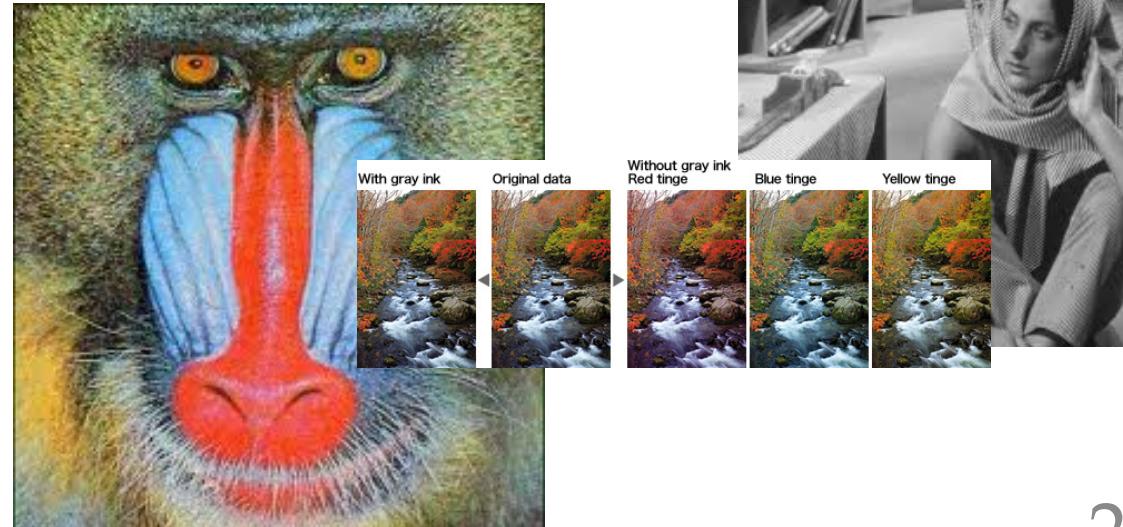
- save `data` `a;`

name of the file (.mat) name of the matrix to be saved

- load data;
 - Re-creates the matrix 'a'.



Image Processing in MATLAB



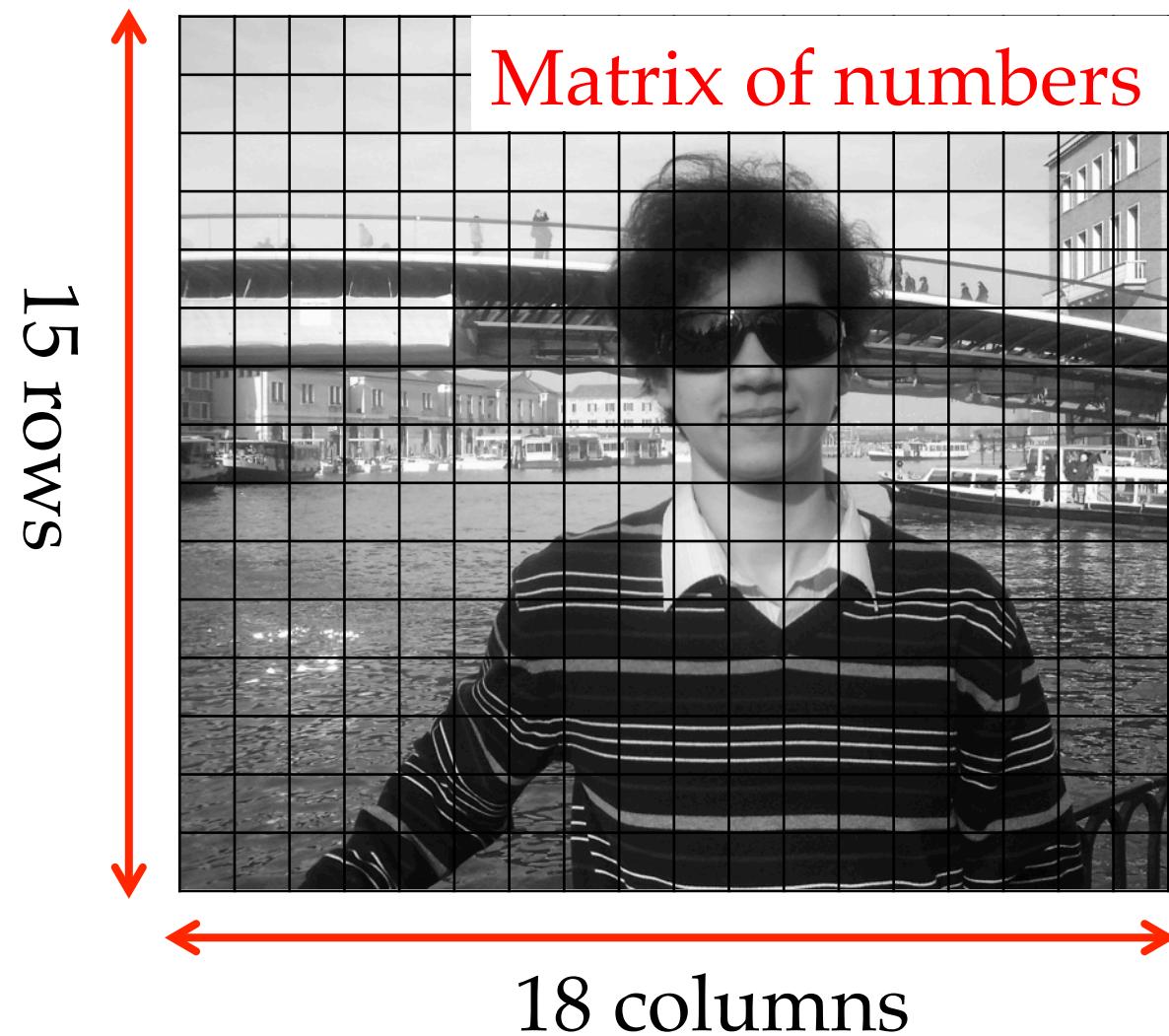
Images in MATLAB



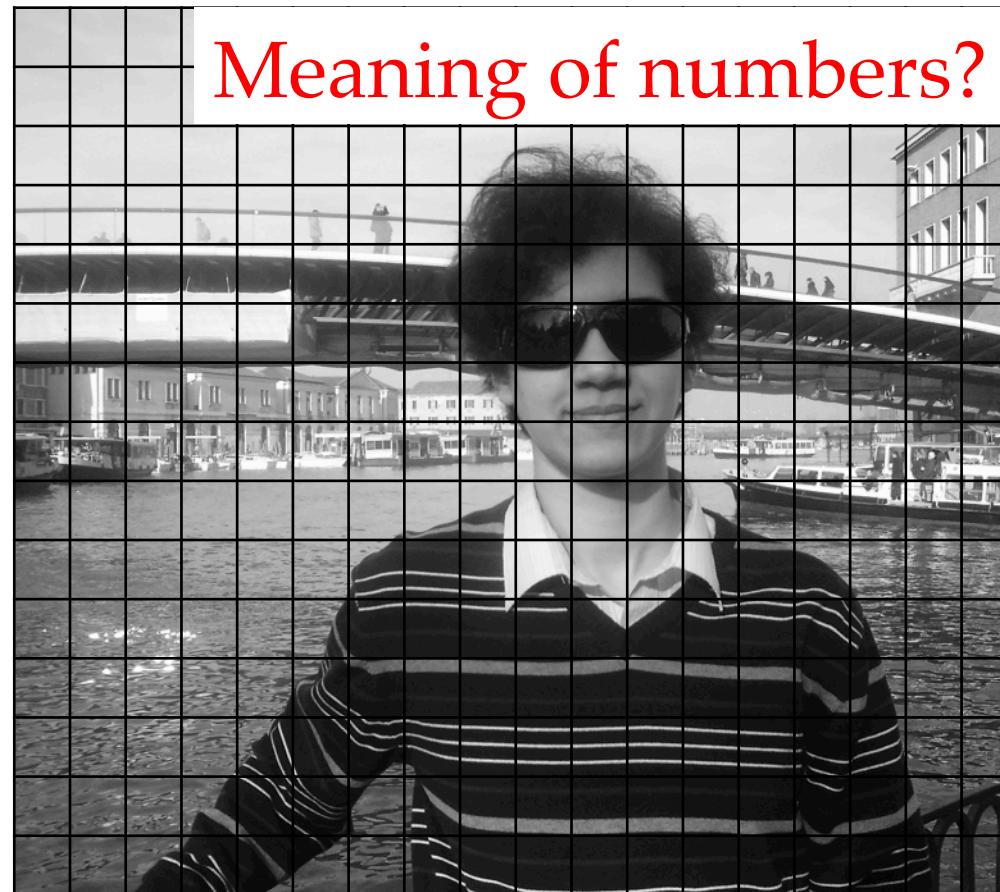
Images in MATLAB



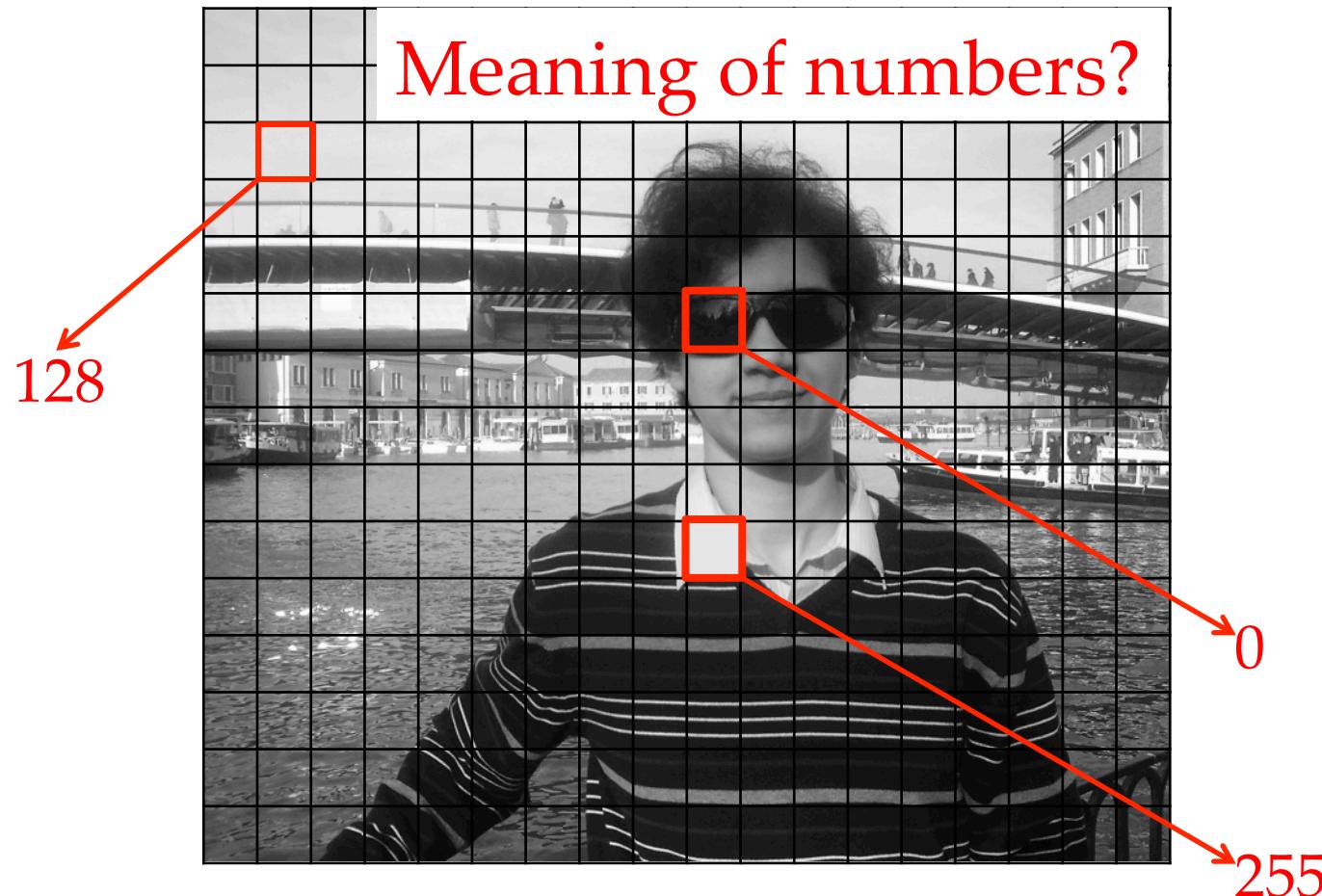
Images in MATLAB



Images in MATLAB



Images in MATLAB



Images in MATLAB



What about color images?

Color Images in MATLAB

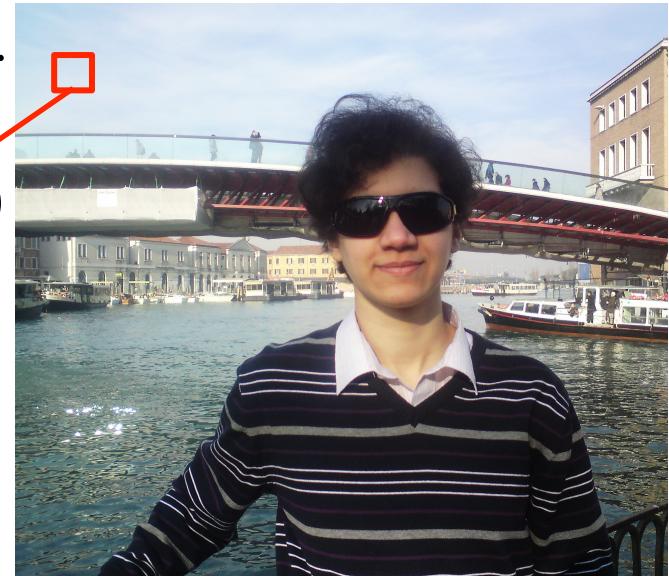
3 channels in color images: red, green, & blue.
3 numbers for each pixel.



Color Images in MATLAB

3 channels in color images: red, green, & blue.
3 numbers for each pixel!

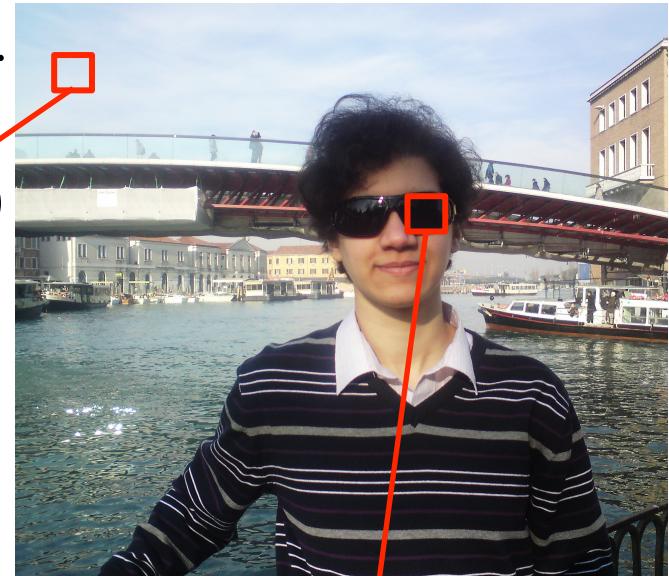
(0,0,255)



Color Images in MATLAB

3 channels in color images: red, green, & blue.
3 numbers for each pixel!

(0,0,255)

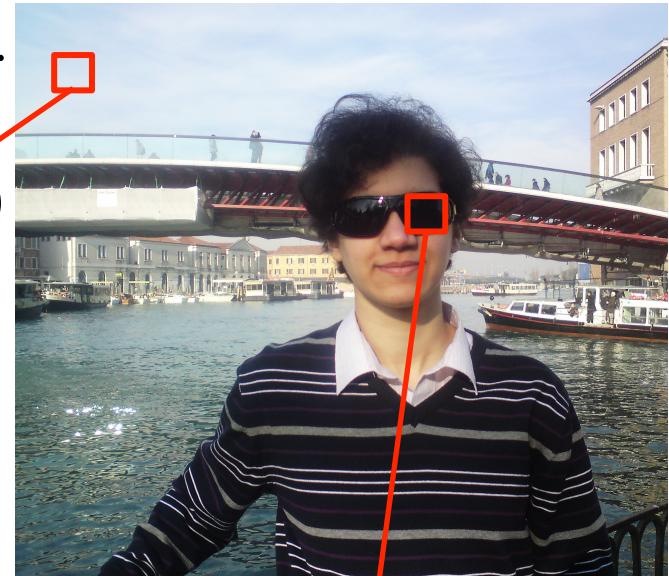


(?, ?, ?)

Color Images in MATLAB

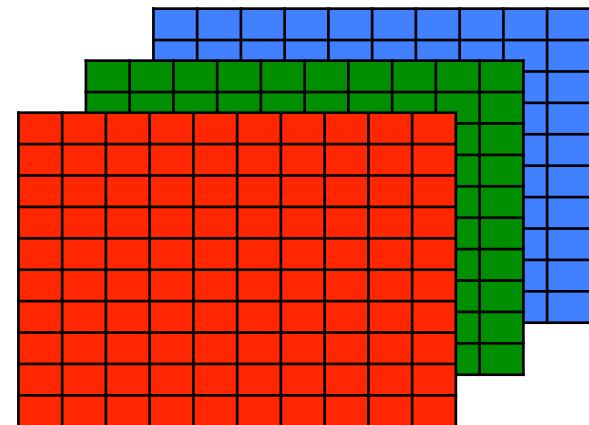
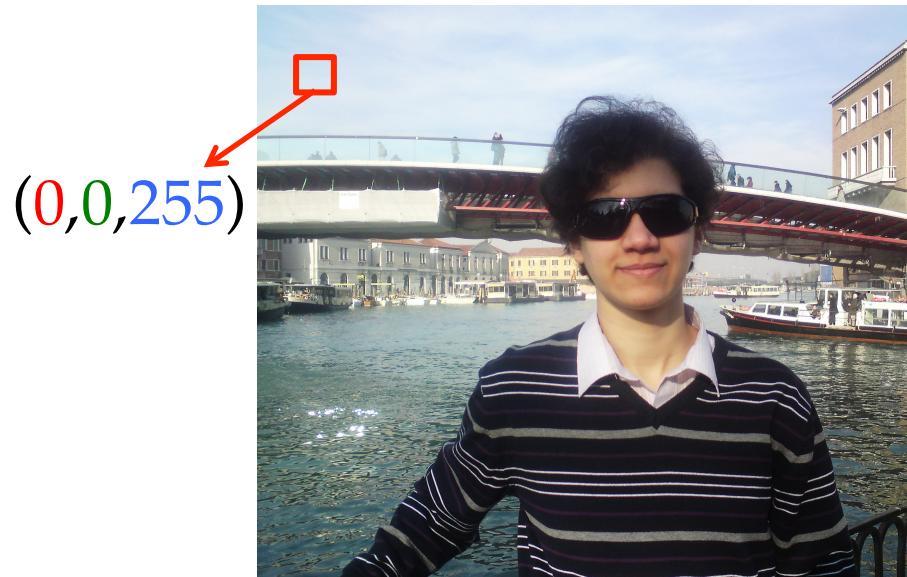
3 channels in color images: red, green, & blue.
3 numbers for each pixel!

(0,0,255)



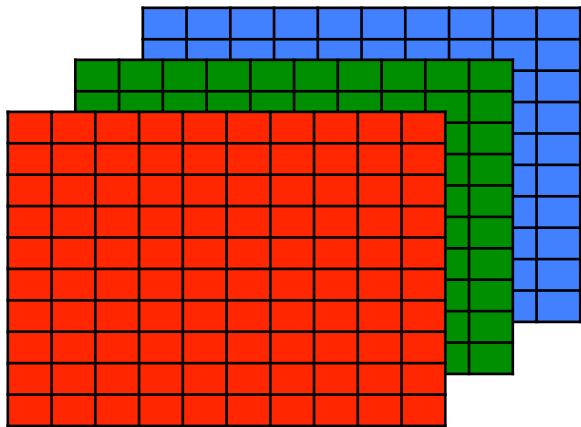
(0,0,0)

Color Images in MATLAB



In MATLAB:
three-dimensional matrices.

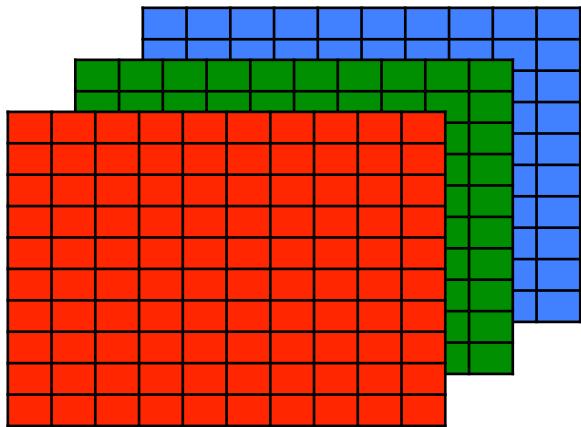
Color Images in MATLAB



`R = image (:,:,1);`

In MATLAB:
three-dimensional matrices.

Color Images in MATLAB

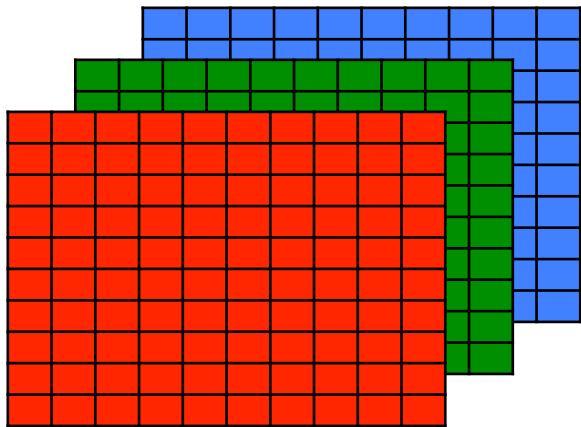


$R = \text{image}(:, :, 1);$

index of row index of color channel
 ↓
 index of column

In MATLAB:
three-dimensional matrices.

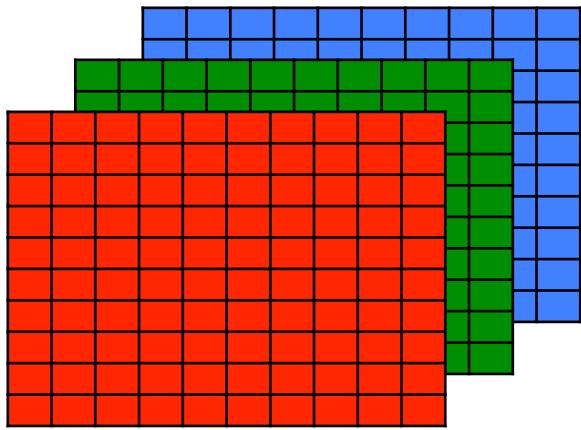
Color Images in MATLAB



```
R = image( :, :, 1);  
G = image( :, :, 2);  
B = image( :, :, 3);
```

In MATLAB:
three-dimensional matrices.

Color Images in MATLAB



```
R = image( :, :, 1);  
G = image( :, :, 2);  
B = image( :, :, 3);
```

RGB values of the first pixel:
 $\text{RGB} = \text{image}(1,1,:)$;

In MATLAB:
three-dimensional matrices.

Don't worry about three-dimensional matrices if you are not clear on them yet.
We will see them in the first exercise.

Image Processing in MATLAB

- Load images: `imread`
- Display images: `imshow`

Image Processing in MATLAB

- Load images: `imread`
- Display images: `imshow`
- Image types:
 - Default: `uint8` -> [0,255]
(`uint8`: unsigned integer in 8 bits)
 - Double: `im2double` -> [0,1]

Let's go to MATLAB

Image Processing in MATLAB

- Load images: `imread`
- Display images: `imshow`
- Image types:
 - Default: `uint8` -> [0,255]
 - Double: `im2double` -> [0,1]
- See the list of useful functions on moodle.
- Start your exercise