

Computing Methods for Experimental Physics and Data Analysis

Data Analysis in Medical Physics

Lecture 2: intro to MATLAB

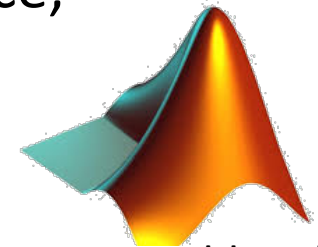
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Brief introduction to MATLAB

- MATLAB (MATrix LABoratory) integrates computation, visualization, and programming in an easy-to-use environment.
- MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.
- MATLAB users come from various backgrounds of engineering, science, and economics.
- First of all: download and install on your laptop:
http://doc.sid.unipi.it/Campus_Matlab
- Follow the link [Come ottenere ed installare MATLAB](#) and then “Istruzioni ad uso degli studenti [\(Installazione MATLAB Student\)](#)”

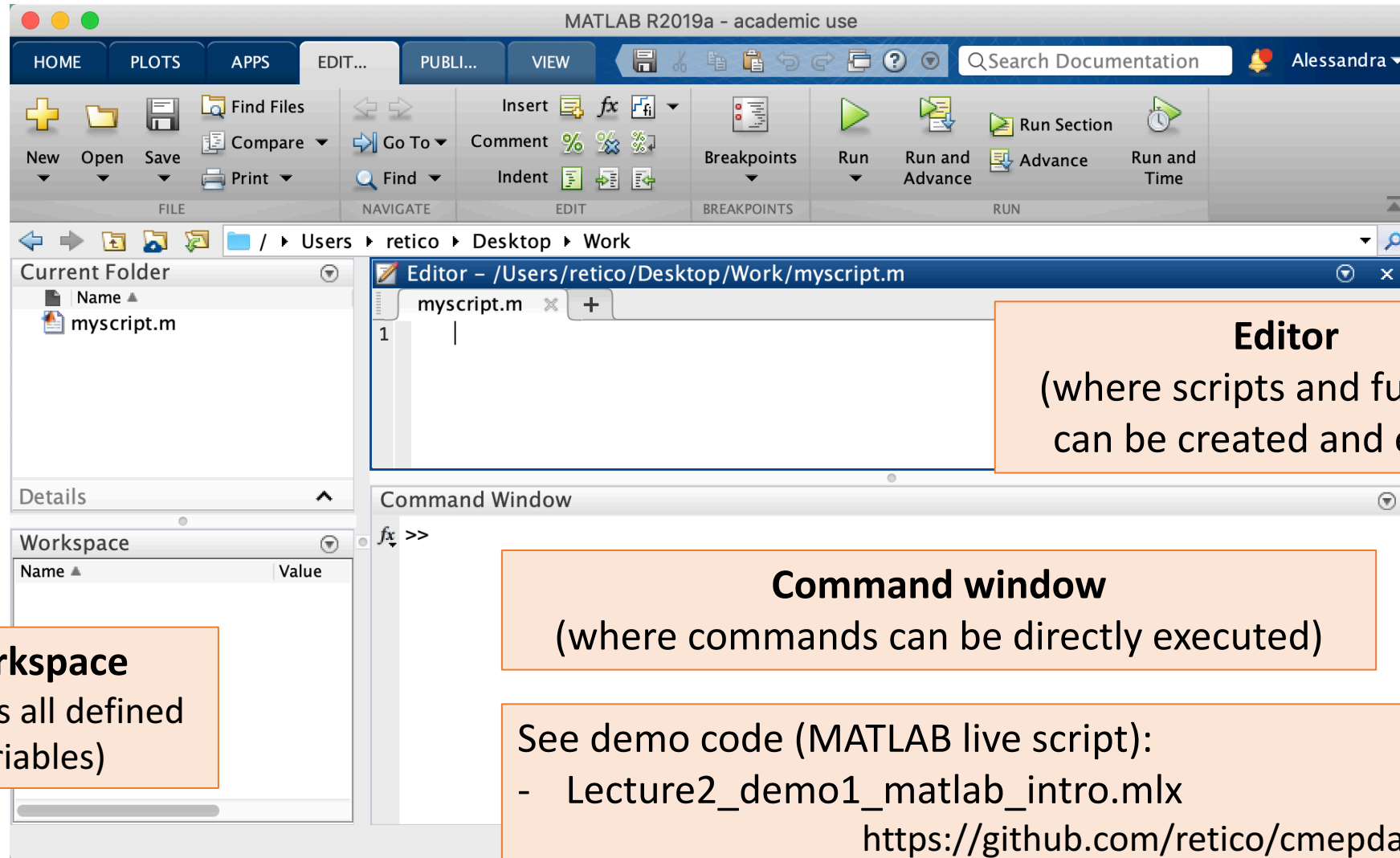


Current stable release
is R2019a

System requirements and useful MATLAB toolboxes

- System requirements for installation:
 - Administrative rights
 - **Processors – Minimum:** any Intel or AMD x86-64 processor
 - **RAM – Minimum:** 3.3 GB. **Recommended:** 8 GB
 - **DISK – Minimum:** 3.3 GB of HDD space for **MATLAB** only, 5-8 GB for a typical installation. **Recommended:** An SSD is recommended
- During the installation you have to specify the products to be installed, i.e. the **MATLAB toolboxes**.
- You may add some toolboxes you like to the suggested ones (e.g. the Statistics and Machine Learning toolbox, the Deep Learning toolbox)
 - Add wavelet toolbox and curve fitting toolbox we will use in exercises
- you can add more toolboxes whenever you need from the Add-Ons drop down menu from the MATLAB desktop HOME tab.

Getting started with matlab

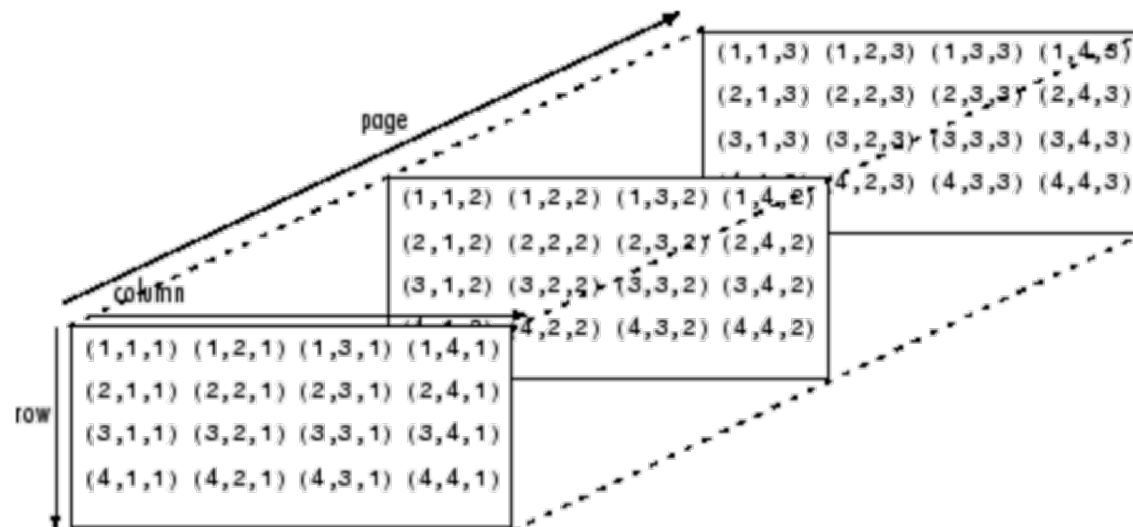


Multidimensional Matlab arrays

A multidimensional array in MATLAB® is an array with more than two dimensions. In a matrix, the two dimensions are represented by rows and columns.

	column →			
row ↓	(1,1)	(1,2)	(1,3)	(1,4)
	(2,1)	(2,2)	(2,3)	(2,4)
	(3,1)	(3,2)	(3,3)	(3,4)
	(4,1)	(4,2)	(4,3)	(4,4)

Each element is defined by two subscripts, the row index and the column index. Multidimensional arrays are an extension of 2-D matrices and use additional subscripts for indexing. A 3-D array, for example, uses three subscripts. The first two are just like a matrix but the third dimension represents *pages* or *sheets* of elements.



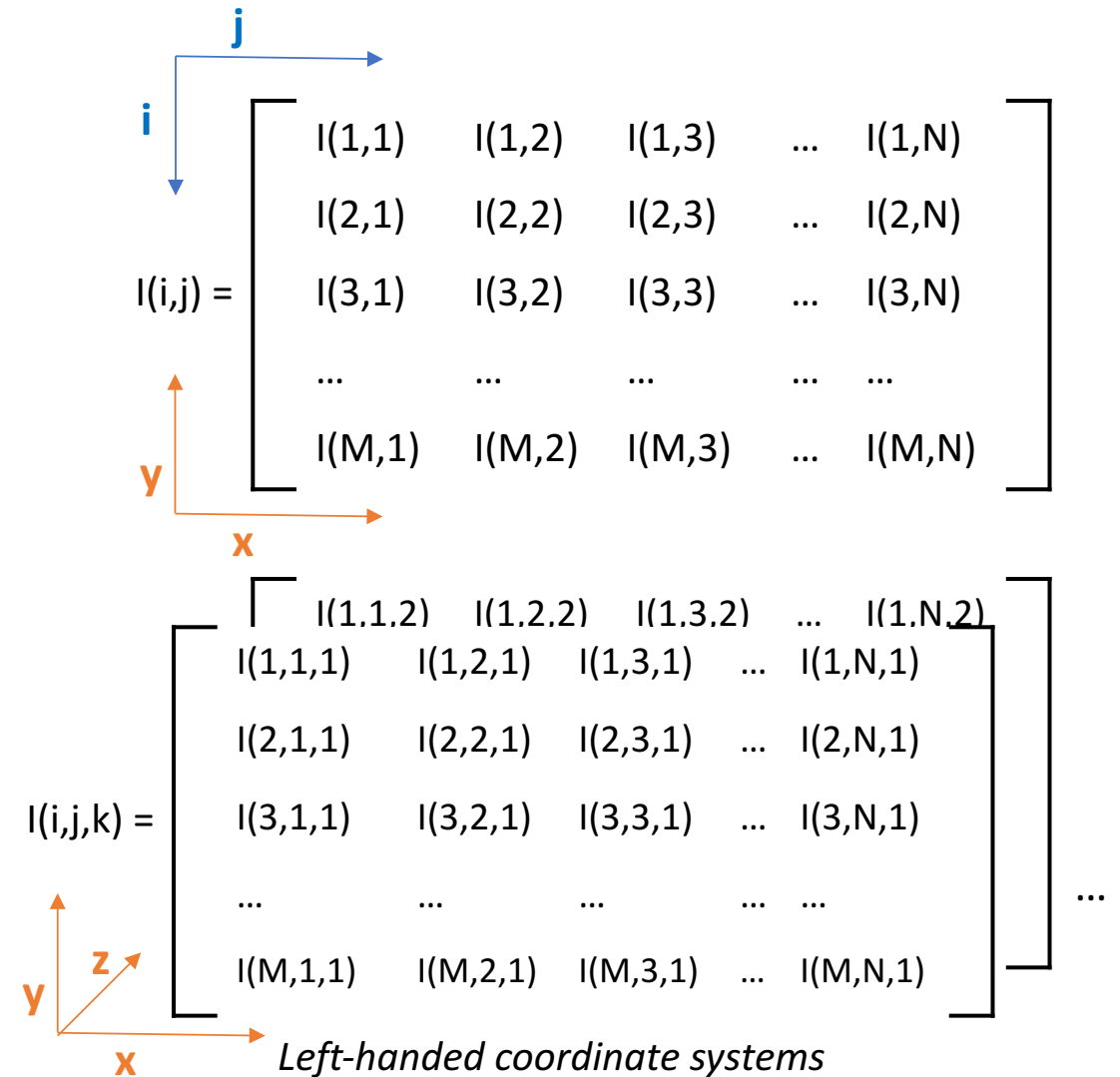
Basic image processing

- Basic operations with images:
 - `imread()`, `imshow()`, `imwrite()`
 - Histogram operations
 - Morphological Operations
 - Image filtering
 - Contrast (C), noise (N), signal-to-noise (SNR) and contrast-to-noise (CNR) ratio
 - ...

- A large variety of functions for image processing are available in the MATLAB Image Processing toolbox

See demo code:

- `Lecture2_demo2_image_read_display.mlx`
- `Lecture2_demo3_read_dicom.m`



Matlab m-files and user-defined functions

- Matlab programs can be written with any ASCII text editor, using the *.m file extension.
- M-files can be executed from the matlab command line:

```
% plot_sin.m  
% this script plots the sinus function  
x=linspace(0,10*pi,200);  
y=sin(x);  
plot(y)
```

```
>> plot_sin      % it works both with and without specifying the .m extension
```

- User defined functions work just like commands in Matlab:

```
function [avg,st_dev]= show_stats(x)  
% This function (show_stats.m) computes the basic statistics (average and standard deviation)  
n = length(x);  
avg = sum(x) / n;  
st_dev = sqrt(sum((x - avg).^2)/n);
```

```
>> v1 = randn(100,1)  
>> [avg_v1,sd_v1]= show_stats(v1)
```

Matlab & git

- The best place to share your MATLAB projects is [File Exchange](#) because of its popularity with the MATLAB user community
- [GitHub](#) is one of the most popular websites that host Git repositories
- Since R2014b [File Exchange is integrated with GitHub](#)
- In addition to what you already know about GitHub usage, you have to follow the instructions to **Register Binary Files with Git**
 - https://it.mathworks.com/help/matlab/matlab_prog/set-up-git-source-control.html

You have to add some lines in the .gitattributes hidden file in your git repository

The .gitattributes file is already correctly set in the https://github.com/retico/cmepda_medphys repository

Add these lines to the .gitattributes file:

```
*.mlx -crlf -diff -merge  
*.mat -crlf -diff -merge  
*.fig -crlf -diff -merge  
...
```


References and sources

- Books

- Digital Image Processing for Medical Applications, Geoff Dougherty
- Handbook of Medical Image Processing and Analysis, Isaac N. Bankman
- Image Processing and Acquisition using Python, Ravishankar Chityala & Sridevi Pudipeddi

- Sources

- http://doc.sid.unipi.it/Campus_Matlab
- <https://it.mathworks.com/help/matlab/getting-started-with-matlab.html>
- <https://it.mathworks.com/videos/>
- <https://it.mathworks.com/help/matlab/external-language-interfaces.html>
- https://it.mathworks.com/help/matlab/matlab_prog/set-up-git-source-control.html
- <https://blogs.mathworks.com/community/2014/10/20/matlab-and-git/>