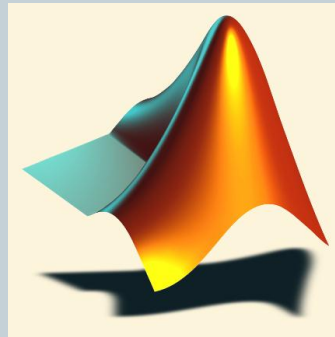


Lecture Series - 1

Introduction to MATLAB

1



by

Shameer Koya

Topics..

2

- What is MATLAB ??
- Basic Matrix Operations
- Complex Number Operations
- Matrices and Arrays
- Polynomials
- Script Files and M-files
- Some more Operations and Functions

APPLICATIONS:

- Plotting functions ..
- Electrical Applications ..

What is MATLAB ??

3

- MATLAB stands for *Matrix Laboratory*.
- Matlab had many functions and toolboxes to help in various applications
- It allows you to solve many technical computing problems, especially those with matrix and vector formulas, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran.
- It also contains functions for 2-D and 3-D graphics and animation.

MATLAB

4

Everything in MATLAB is a matrix !

MATLAB

5

- The MATLAB environment is command oriented somewhat like UNIX. A prompt appears on the screen and a MATLAB statement can be entered. When the <ENTER> key is pressed, the statement is executed, and another prompt appears.
- If a statement is terminated with a semicolon (;), no results will be displayed. Otherwise results will appear before the next prompt.

The MATLAB User Interface

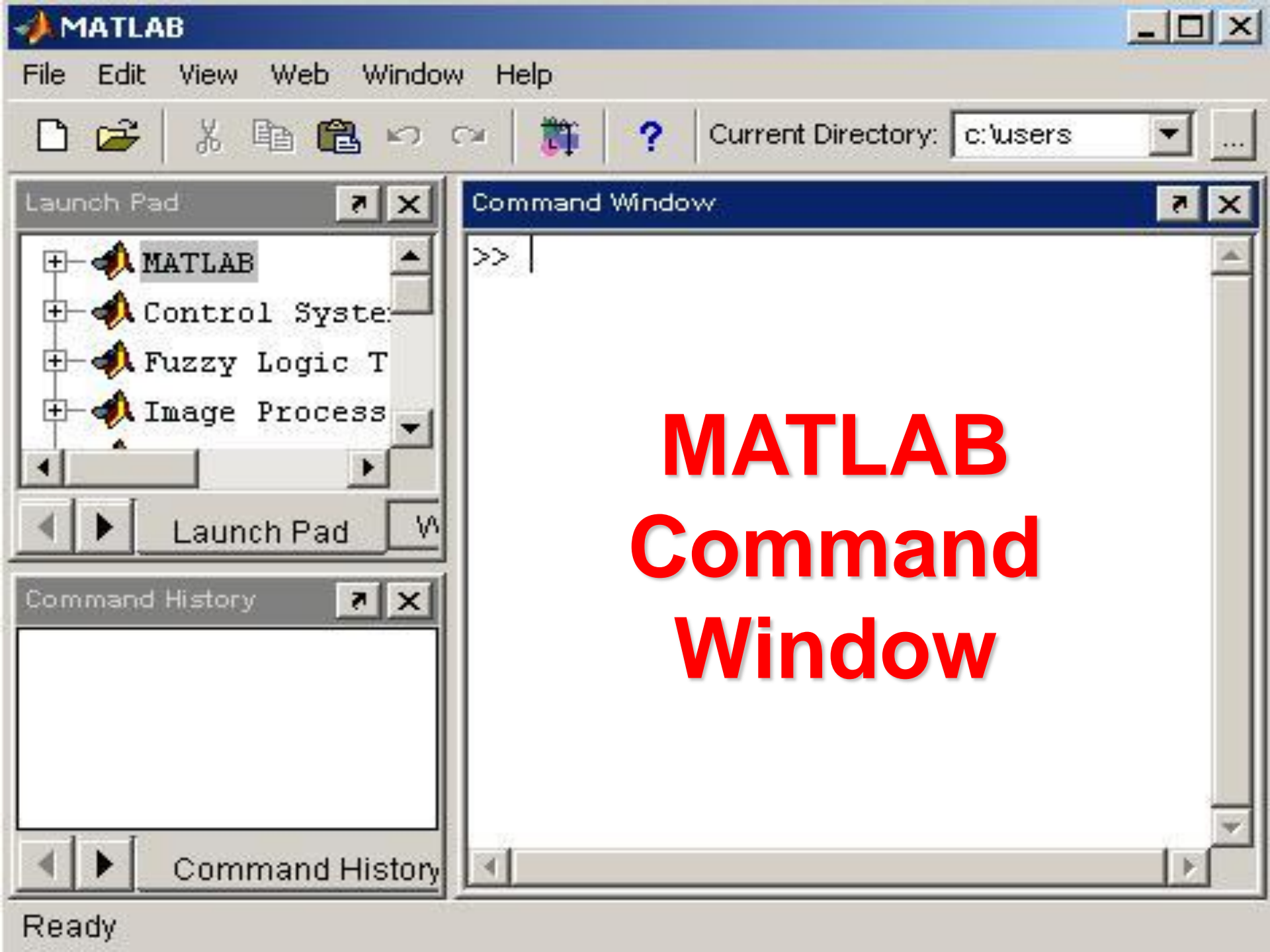
6

The screenshot displays the MATLAB environment with three main windows:

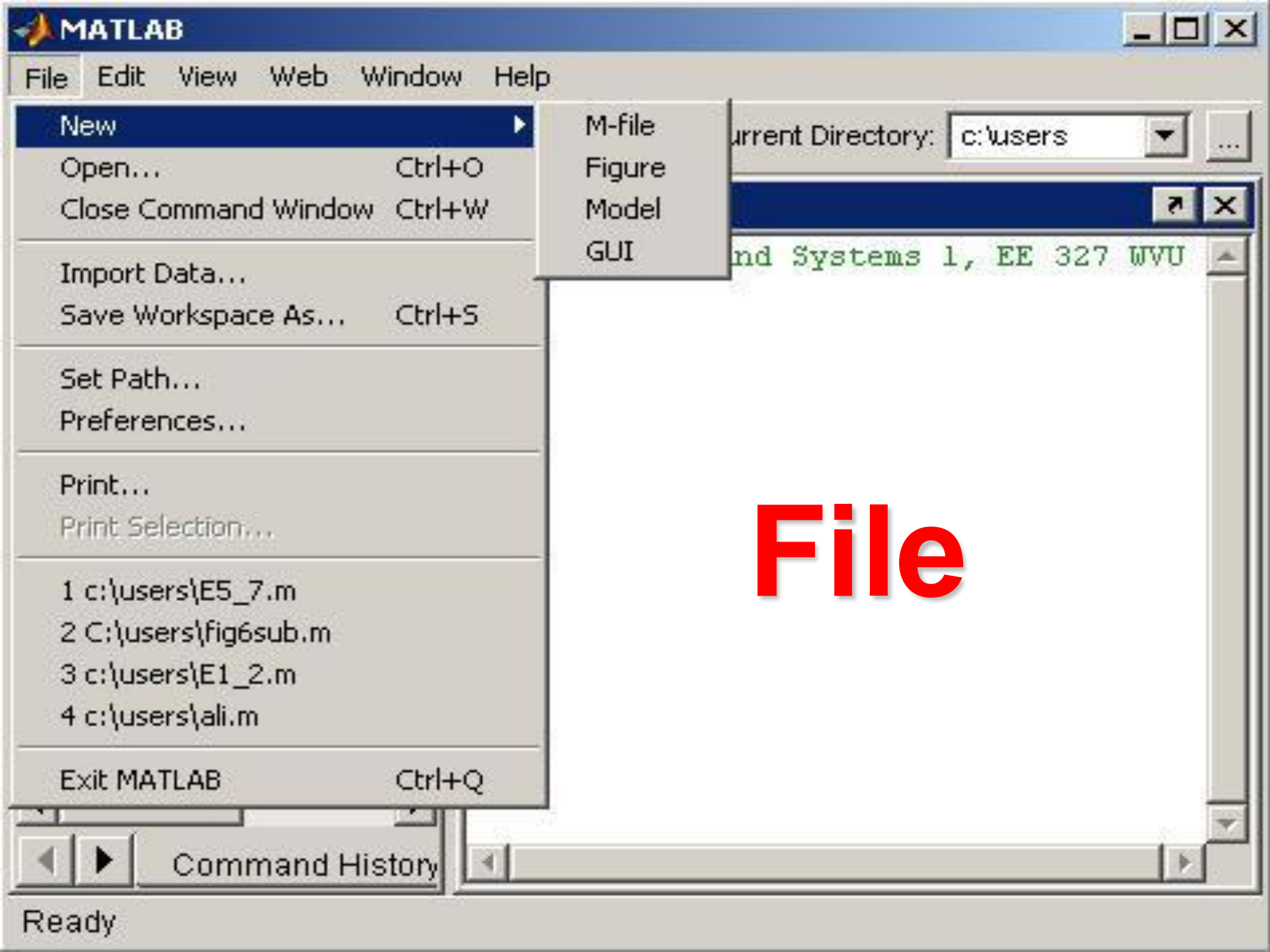
- Workspace:** A window with a table listing variables. A blue box highlights it with the text: "This is the workspace which lists all the variables you are using."
- Command Window:** A window for entering and executing commands. A red box highlights it with the text: "This is the command window, you can enter commands and data, and the results are displayed here." A green circle highlights the prompt `>>` with the text: "You may type the commands after the '>>' symbol."
- Command History:** A window showing a log of previously entered commands. A green box highlights it with the text: "This is the command history window, it displays a log of the commands used."

At the top, the **Current Directory** is set to `d:\MATLAB6p5\work`, highlighted in yellow with the text: "This is the directory that matlab will look at for all the files, make sure it is set to the right folder."

The MATLAB menu bar includes File, Edit, View, Web, Window, and Help. The Command Window contains the text: "Using Toolbox Path Cache. Type 'help toolbox_path_cache' for more info. To get started, select 'MATLAB Help' from the Help menu."



MATLAB Command Window



MATLAB

File Edit View Web Window Help

- New
- Open... Ctrl+O
- Close Command Window Ctrl+W
- Import Data...
- Save Workspace As... Ctrl+S
- Set Path...
- Preferences...
- Print...
- Print Selection...
- 1 c:\users\E5_7.m
- 2 C:\users\fig6sub.m
- 3 c:\users\E1_2.m
- 4 c:\users\ali.m
- Exit MATLAB Ctrl+Q

- M-file
- Figure
- Model
- GUI

Current Directory: c:\users

nd Systems 1, EE 327 WVU

File

Command History

Ready

Undo Ctrl+Z
Redo
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Paste Special...
Select All
Delete
Clear Command Window
Clear Command History
Clear Workspace

Current Directory: c:\users

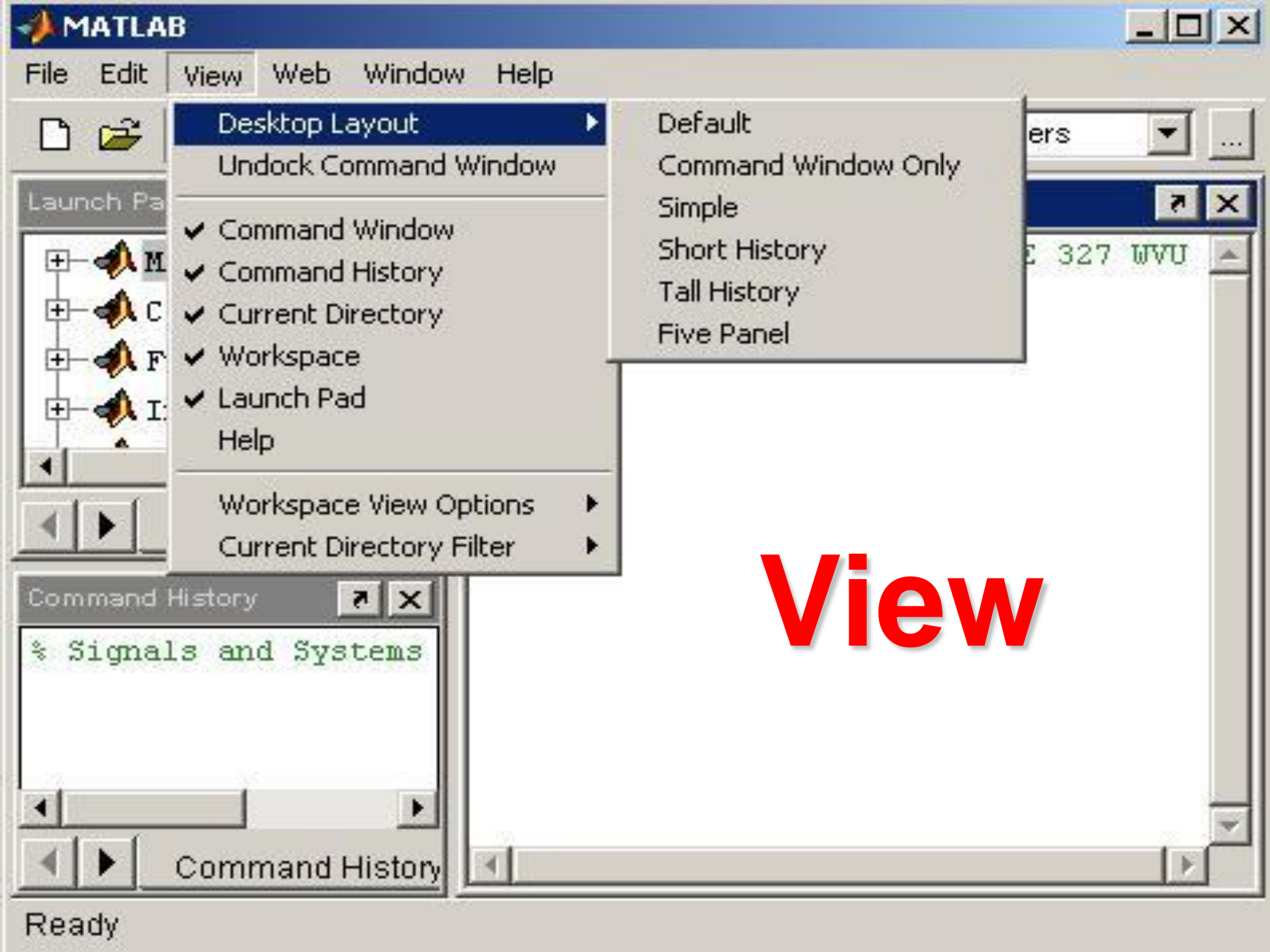
Window

```
signals and systems 1, EE 327 WVU
```

Edit

```
% Signals and Systems
```

Command History



MATLAB

File Edit View Web Window Help



Desktop Layout
Undock Command Window

Launch Pa



- ✓ Command Window
- ✓ Command History
- ✓ Current Directory
- ✓ Workspace
- ✓ Launch Pad
- Help

Workspace View Options
Current Directory Filter

- Default
- Command Window Only
- Simple
- Short History
- Tall History
- Five Panel

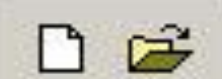
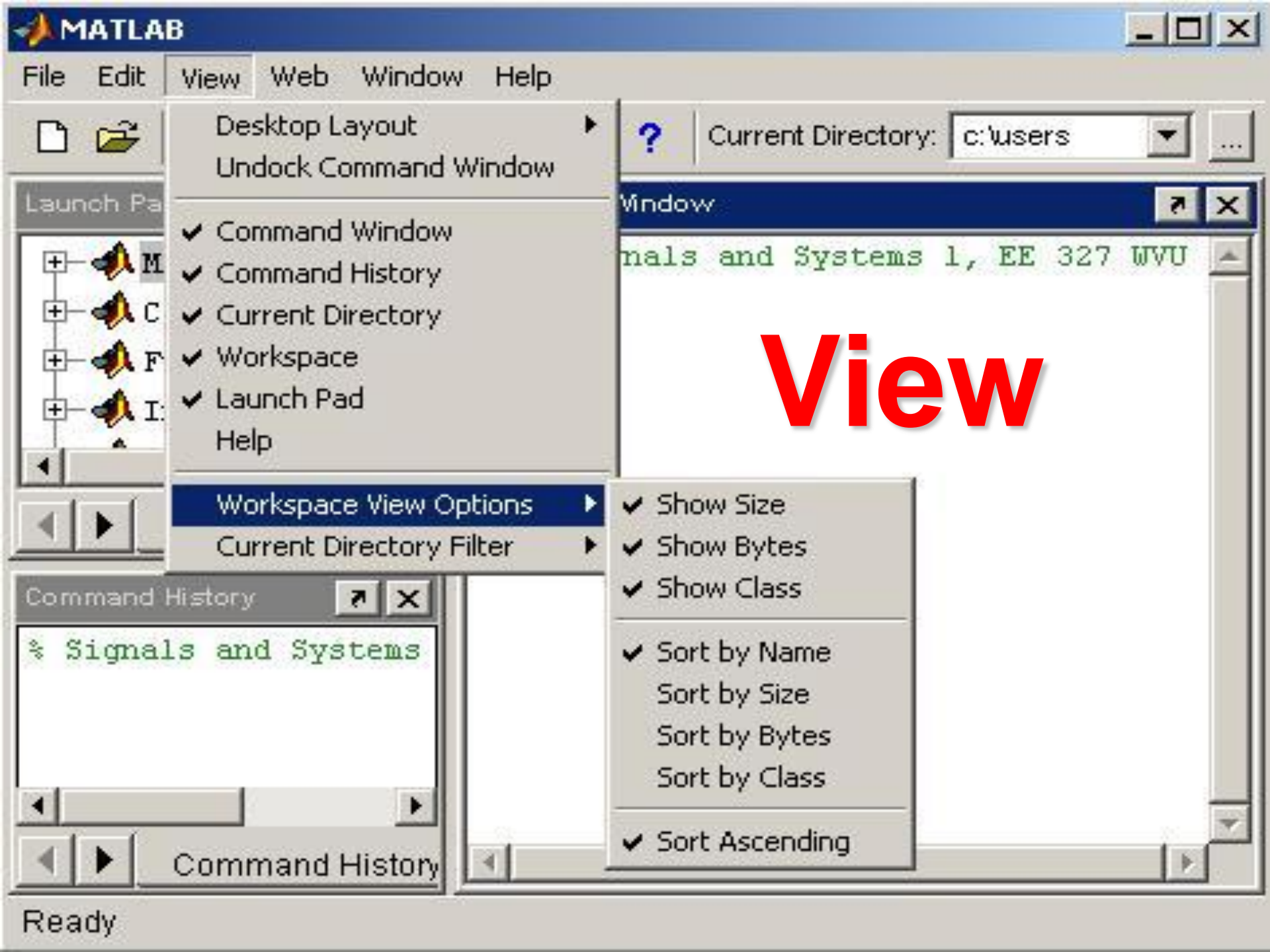
Command History

```
% Signals and Systems
```

Command History

View

Ready



Desktop Layout
Undock Command Window

Launch Pa



- Command Window
- Command History
- Current Directory
- Workspace
- Launch Pad
- Help

Workspace View Options
Current Directory Filter

Current Directory: c:\users

Window

Signals and Systems 1, EE 327 WVU

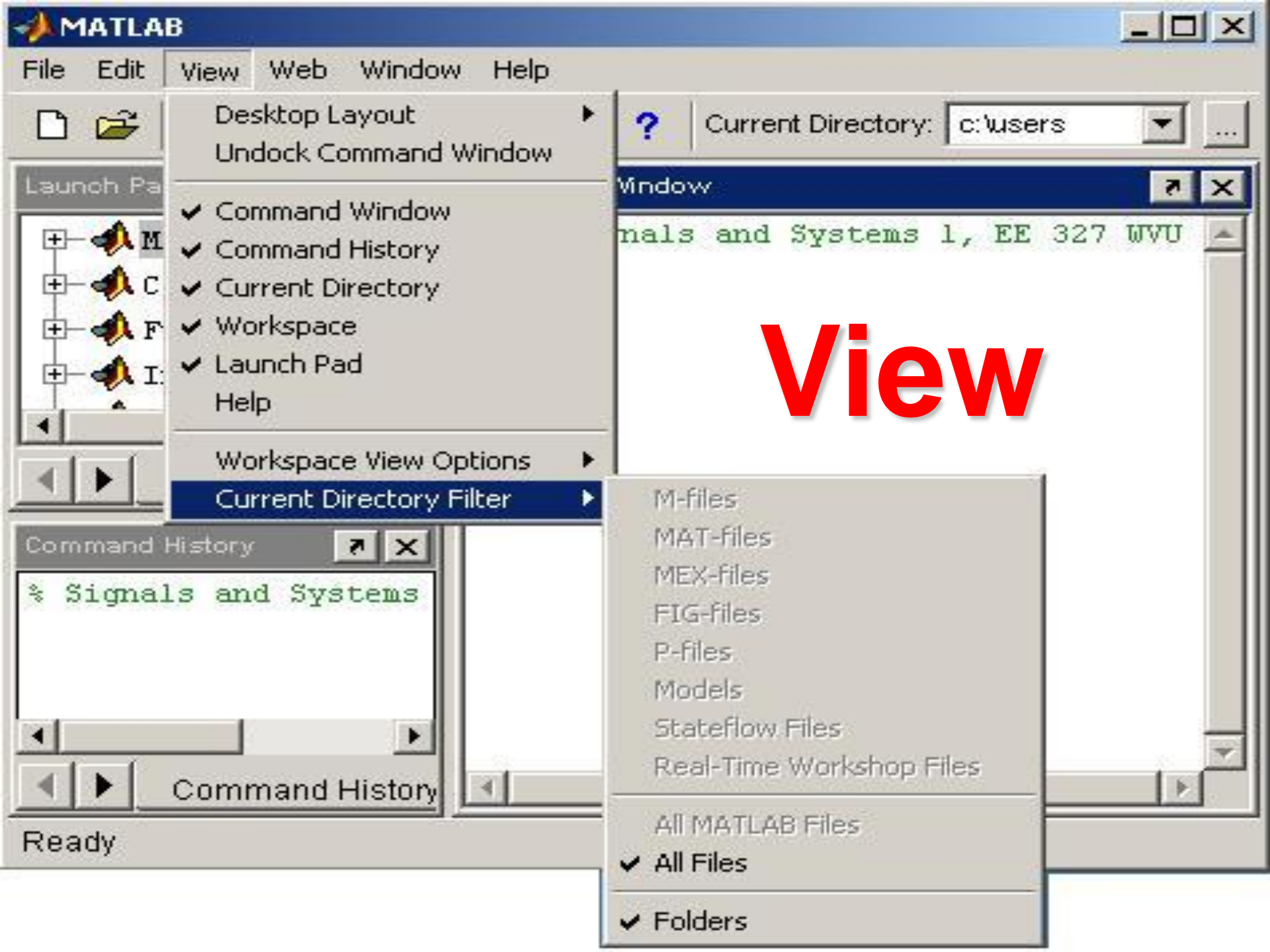
View

- Show Size
- Show Bytes
- Show Class
- Sort by Name
- Sort by Size
- Sort by Bytes
- Sort by Class
- Sort Ascending

Command History

% Signals and Systems

Command History



Desktop Layout
Undock Command Window

Launch Pa



- ✓ Command Window
- ✓ Command History
- ✓ Current Directory
- ✓ Workspace
- ✓ Launch Pad
- Help

Workspace View Options
Current Directory Filter

Current Directory: c:\users

Window

```
Signals and Systems 1, EE 327 WVU
```

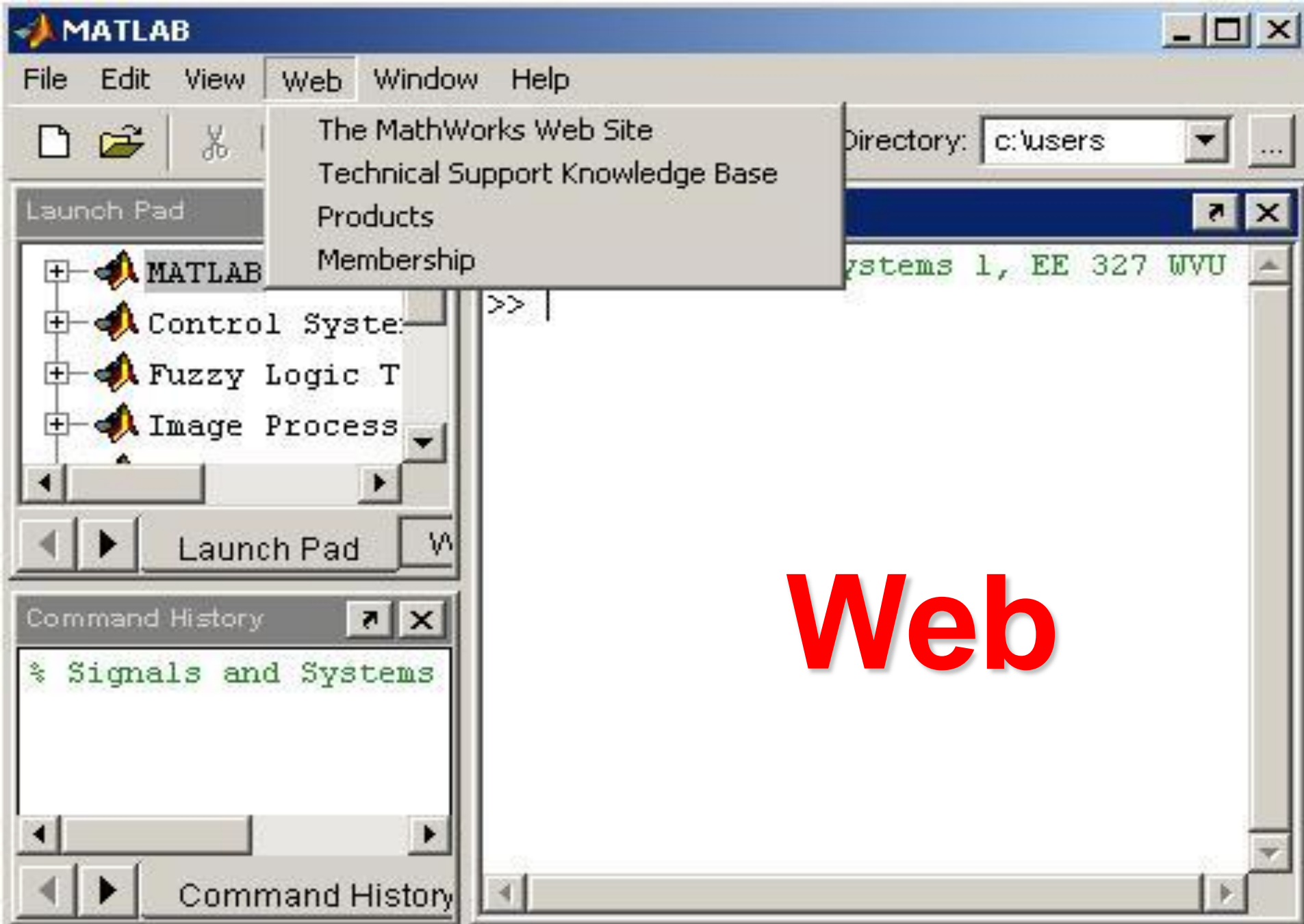
View

- M-files
- MAT-files
- MEX-files
- FIG-files
- P-files
- Models
- Stateflow Files
- Real-Time Workshop Files
- All MATLAB Files
- ✓ All Files
- ✓ Folders

Command History

```
» Signals and Systems
```

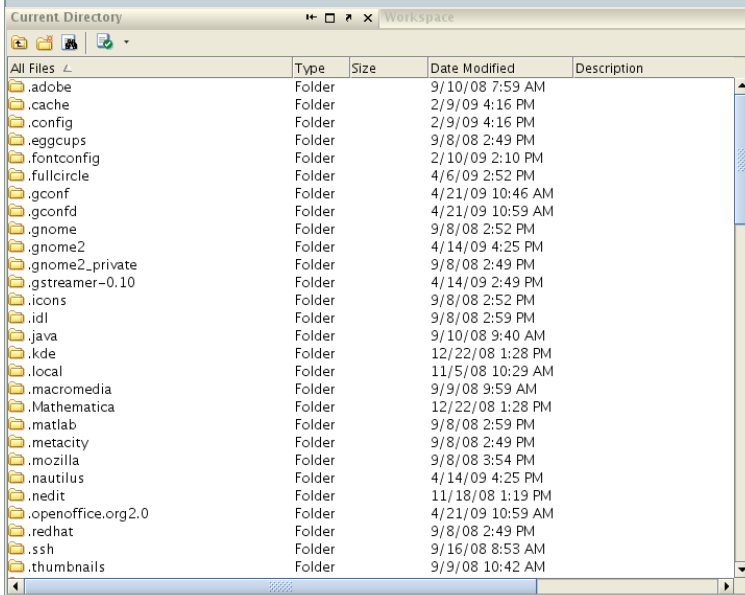
Command History



Web

MATLAB GUI – Current Directory

Current Directory:

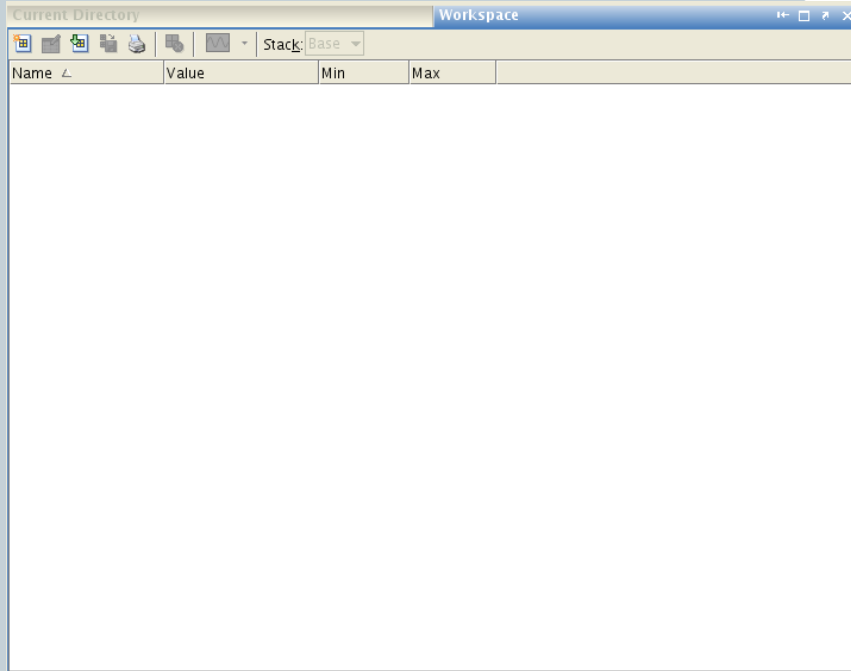


- **Setting the path:**
 - You need to set up what directory to save your files to
 - Multiple options: directory commands, current directory path, current directory window
 - Directory commands: `pwd`, `cd`, `dir`, `ls`, `path`, `editpath`, `copyfile`, `mkdir`
- **When in doubt, check your path**

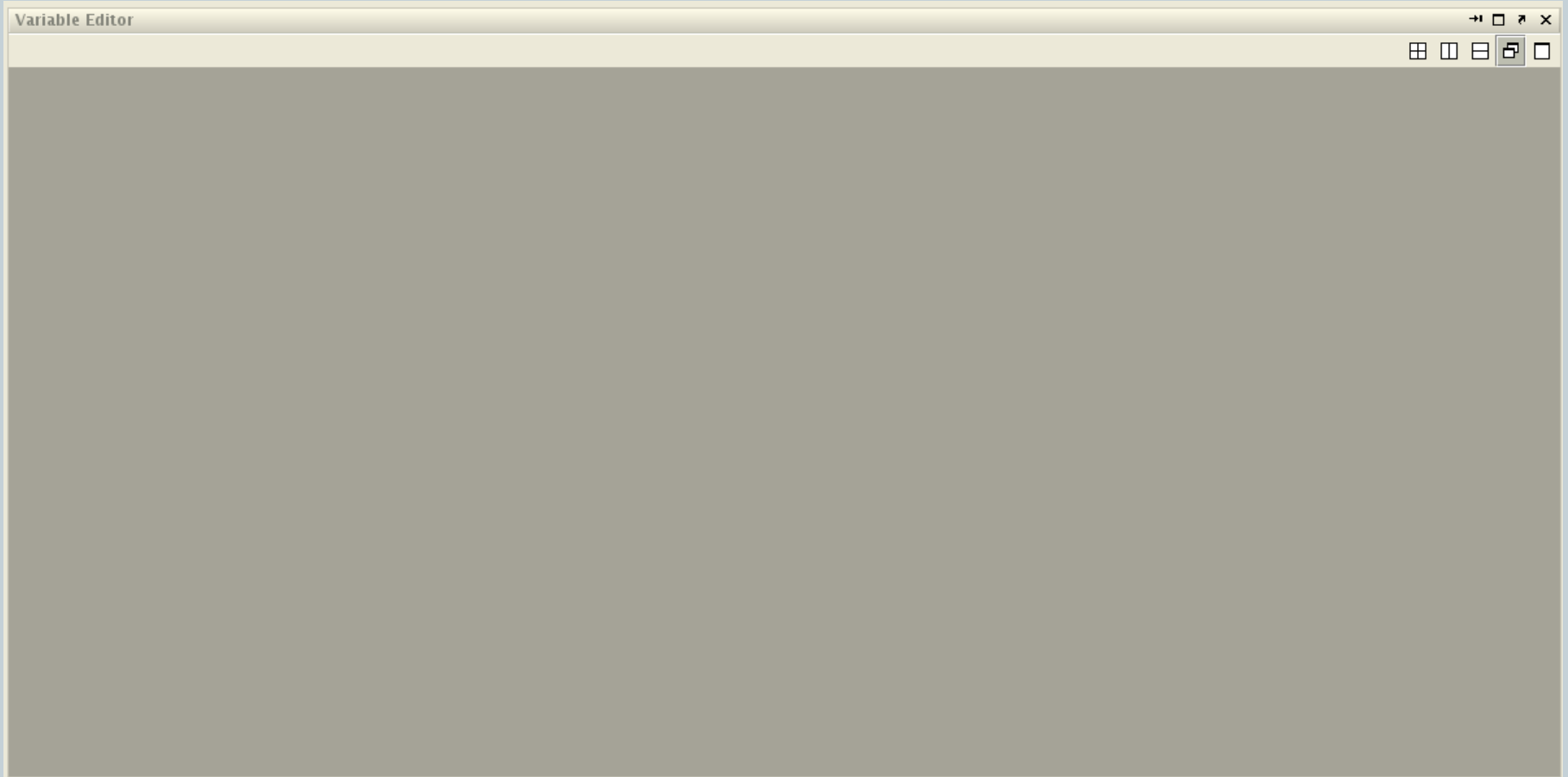
MATLAB GUI – Command Window



MATLAB GUI – Workspace



MATLAB GUI – Variable Editor



MATLAB GUI – Command History

A screenshot of the MATLAB Command History window. The window title is "Command History" and it has standard window controls (back, forward, home, end, search, close). The content shows a list of commands and their execution times, grouped by date. The commands include plotting functions, string conversions, directory creation, and file operations. The window has a vertical scrollbar on the right side.

```
Command History
--AIRC_lifetime_plot
--num2str(1)
--test=numstr(1)
--test=num2str(1)
--AIRC_lifetime_plot
--test_plot
--AIRC_lifetime_plot
%-- 2/24/09 3:18 PM --%
%-- 2/24/09 7:28 PM --%
%-- 2/24/09 7:29 PM --%
%-- 2/27/09 4:01 PM --%
%-- 2/28/09 2:37 PM --%
--mkdir matlab_input
--mkdir matlab_output
--make_output_file
--cd ~
--cd ~/psndbp_model/psndbp-1.3/
--clear
--weekend_job
%-- 3/4/09 11:41 AM --%
--weekend_job2
--clear
--weekend_job2
%-- 4/21/09 11:03 AM --%
```

MATLAB GUI – Additional Windows



- Editor window
 - Will discuss with scripts and functions
- Figure window
 - Will discuss with graphics

MATLAB Help



- **Three common ways to access:**
 - Type `help topic` at command line
 - Select help from drop-down menus (opens help window)
 - Mathworks website
 - `help`, `helpwin`, `helpdesk`
- **MATLAB help is very comprehensive**



- Full Product Family Help
- MATLAB Help
- Using the Desktop
- Using the Command Window
- Demos
- About MATLAB

Launch Pad

- MATLAB
- Control Systems
- Fuzzy Logic Toolbox
- Image Processing

Launch Pad

Command History

```
» Signals and Systems
```

Command History

c:\users

EE 327 WVU

Help

Help

File Edit View Go Web Window Help

Help Navigator

Product filter: All Selected

Contents Index Search Demos Favorites

- Begin Here
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 - Programming and Data Types
 - Graphics
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 - Creating Graphical User Interfaces
 - Functions - By Category
 - Functions - Alphabetical List
 - Handle Graphics Property Browser
 - External Interfaces/API
 - External Interfaces/API Reference
 - Release Notes
 - Printable Documentation (PDF)
 - Product Page (Web)
- Control System Toolbox
- Neural Network Toolbox
- Optimization Toolbox
- Signal Processing Toolbox
- Statistics Toolbox
- Support and Web Services

← → ↻ 📄 Find in page:

MATLAB

R o a d m a p

MATLAB®

■ Learning MATLAB

- ◆ [Getting Started](#) - introduction to MATLAB.
- ◆ [Using MATLAB](#) - user guides for all of MATLAB.
- ◆ [Programming Tips](#) - tips on many aspects of programming with MATLAB.
- ◆ [Examples](#) - major examples in the MATLAB documentation.
- ◆ [Release Notes](#) - summary of new features, bug fixes, upgrade issues, etc.

■ Finding Functions and Properties

- ◆ [MATLAB Functions Listed by Category](#) - browse MATLAB functions by category.
- ◆ [MATLAB Functions Listed Alphabetically](#) - find functions from an alphabetical list.

If you know the function name:

1. Click **Search** in the Help Browser's left pane
2. Select **Function Name** for the type of search
3. Enter the name of the function in the **Search for** field and click **Go**.

- ◆ [Handle Graphics Property Browser](#) - view descriptions of all graphics object properties.

■ Printing the Documentation

- ◆ [Printable versions](#) of the MATLAB documentation and related papers in PDF format.



MATLAB Demos

- +MATLAB
- Toolboxes
 - Control System
 - Fuzzy Logic
 - Image Processing
 - Neural Networks
 - Signal Processing
 - Statistics
 - System Identificatio
 - Wavelet
- +Simulink
- +Blocksets
- +Stateflow

Toolboxes are specialized collections of M-files (MATLAB language programs) built specifically for solving particular classes of problems.

Our Toolboxes represent the efforts of some of the world's top researchers in fields such as controls, signal processing,

Choose a subtopic to see a list of demos

Close

Run

Arrays and Matrices



- MATLAB is designed for use with matrices, so many functions are optimized for matrix use
- This will be discussed further next week

MATLAB Variable Names

25

- Variable names ARE case sensitive
- Variable names can contain up to 63 characters (as of MATLAB 6.5 and newer)
- Variable names must start with a letter followed by letters, digits, and underscores.
- Can contain any combination of letters, digits, and underscores
- Special functions that are already defined, but can be overwritten (temporarily)

pi, i, j, eps, realmin, realmax, Inf, NaN

- Don't use function names

Namelength max, which -all var_name, isvarname

Variables – Types



- Numeric
- Logical
- Strings and Character (discussed further with file I/O)
- Cell arrays and structures (discussed further with file I/O)
- Function handles (discussed further with graphics)

MATLAB Special Variables

27

ans	Default variable name for results
pi	Value of π
eps	Smallest incremental number
inf	Infinity
NaN	Not a number e.g. 0/0
i and j	$i = j = \text{square root of } -1$
realmin	The smallest usable positive real number
realmax	The largest usable positive real number

Variables

28

- To recall the variable

- » D

D =

2

- Use arrow keys for scrolling through previous commands

- List of variables in the workspace

- » who

D b a ans

- To clear variables

- » clear D

- » clear

Order of Operations



- **Standard order of operations is enforced in MATLAB**
 - Parentheses
 - Exponentiation
 - Multiplication and Division
 - Addition and Subtraction
- **When in doubt, add parentheses**
- **MATLAB can help you keep track of ()**

Other MATLAB symbols

31

>>	prompt
...	continue statement on next line
,	separate statements and data
%	start comment which ends at end of line
;	(1) suppress output (2) used as a row separator in a matrix
:	specify range

MATLAB Relational Operators

32

- MATLAB supports six relational operators.

Less Than	<	
Less Than or Equal	<=	
Greater Than	>	
Greater Than or Equal	>=	
Equal To	==	
Not Equal To	~=	

MATLAB Logical Operators

33

- MATLAB supports three logical operators.

not	~	% highest precedence
and	&	% equal precedence with or
or		% equal precedence with and

Logical Operations



- `&`, `|`, `~`, `xor`
- `&&`, `||`

Simple Math

35

» $a=5;$

» $b=a/2$

$b =$

2.5000

» $2+2.5+106$

$ans =$

110.5000

» $4*25 + 2^3$

$ans =$

108

Built-in Functions

36

Trigonometric functions	sin, cos, tan, sinh, cosh, tanh, asinh, acosh, atanh, csc, sec, cot, acsc, ...
Exponential functions	exp, log, log10, sqrt
Complex functions	abs, angle, imag, real, conj
Rounding and Remainder functions	floor, ceil, round, mod, rem, sign

Numbers and variables and similar in Matlab



- Smallest positive floating point number $2.2251e-308$, and the highest is $1.7977e+308$.
- Spacing of floating point numbers (calculation precision) is $2.2204e-016$.
- $1/0$ gives infinite - *Inf*.
- $0/0$ or *Inf-Inf* gives *NaN* – (not-a-number).
- Matlab is case sensitive; $a = 10$ is not equal to $A = 10$.
- If the command is concluded with semicolon, the result will not be shown on the screen.
- For decimal numbers, dot is used, for example 2.45.
- Formats: format short, format long, format long e...format.
- *% Comment*.

Numbers and variables and similar in Matlab



- $2.4e-12$ is $2.4 * 10^{-12}$
- π is the variable with defined name.
- i or j is complex unit (it can be overwritten).
- For trigonometric functions [rad] is used.
- `clear all`, clears all defined variables.
- `close all`, closes all graphical windows.
- `clear all`, `close all`, very usefull combination!
- `clc`, clears the screen, but nothing else.
- CTRL+C stop the execution of the program in Matlab.
- `dir`, current directory.
- `who`, list of all defined variables.

Basic Matlab Operations



```
>> % This is a comment, it starts with a "%"
>> y = 5*3 + 2^2;           % simple arithmetic
>> x = [1 2 4 5 6];        % create the vector "x"
>> x1 = x.^2;              % square each element in x
>> E = sum(abs(x).^2);      % Calculate signal energy
>> P = E/length(x);        % Calculate av signal power
>> x2 = x(1:3);            % Select first 3 elements in x
>> z = 1+i;                % Create a complex number
>> a = real(z);            % Pick off real part
>> b = imag(z);            % Pick off imaginary part
```

Basic Matlab Operations ...

40

```
>> plot(x); % Plot the vector as a signal
>> t = 0:0.1:100; % Generate sampled time
>> x3=exp(-t).*cos(t); % Generate a discrete signal
>> plot(t, x3, 'x'); % Plot points
>> x=sqrt(2)/2 % Built in functions
>> y=sin(x) % Trigonometric functions
```


Thanks

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Questions ??