MATLAB: Introduction

Part 1

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Outline

Outline

A powerful tool!

- MATLAB stands for *Matrix Laboratory*
- Enhanced by *toolboxes* (specific routines for an area of application)
  - Optimization
  - Statistics
  - Control System
  - Bioinformatics
  - . . .
- Excellent for numerical computations
- Commonly regarded as a 'Rapid Prototyping Tool'
- Used in industry and academia

Help with MATLAB?

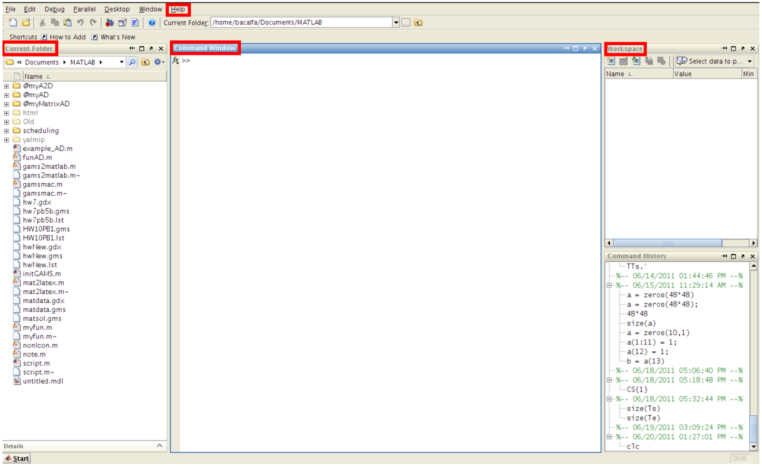
- MATLAB's Help
- Google
- A book about MATLAB

Outline

Main Window I

- Command Window (prompt $>>$)
- Current Directory
- Workspace (contains variables stored in memory)
- Help Menu

Main Window II



```
@myA2D
@myAD
@myMatrixAD
html
Old
scheduling
yalmip
example_AD.m
funAD.m
gams2matlab.m
gams2matlab.m~
gamsmac.m
gamsmac.m~
hw7.gdx
hw7pb5b.gms
hw7pb5b.lst
HW10PB1.gms
HW10PB1.lst
hwNew.gdx
hwNew.gms
hwNew.lst
initGAMS.m
mat2latex.m
mat2latex.m~
matdata.gdx
matdata.gms
matsol.gms
myfun.m
myfun.m~
nonlcon.m
note.m
script.m
script.m~
untitled.mdl
```

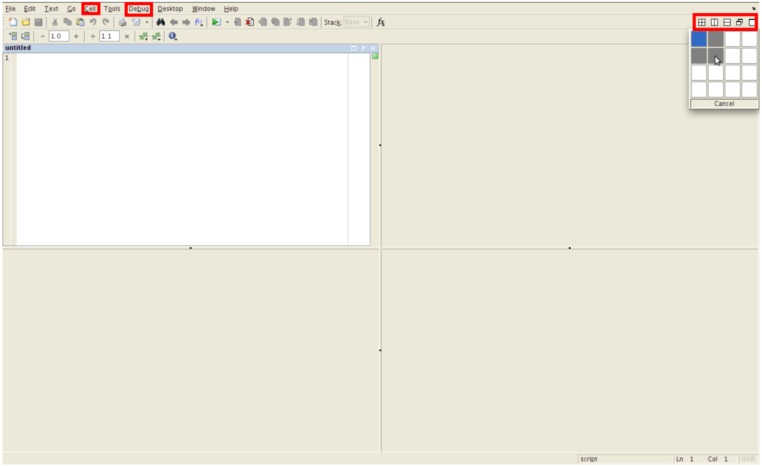
```
>>
```

```
TTs.'
%-- 06/14/2011 01:44:46 PM --%
%-- 06/15/2011 11:29:14 AM --%
  a = zeros(48*48)
  a = zeros(48*48);
  48*48
  size(a)
  a = zeros(10,1)
  a(1:11) = 1;
  a(12) = 1;
  b = a(13)
%-- 06/18/2011 05:06:40 PM --%
%-- 06/18/2011 05:18:48 PM --%
  CS{1}
%-- 06/18/2011 05:32:44 PM --%
  size(Ts)
  size(Te)
%-- 06/19/2011 03:09:24 PM --%
%-- 06/20/2011 01:27:01 PM --%
  clc
```

Editor Window I

- Window Menu (Tile)
- Debug Menu (Run, Step, Step In, Step Out...)
- Cell Menu (Cell Mode)

Editor Window II



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Basic Operators

- MATLAB supports the following mathematical operators

Operator	**Operation**
$+$	Addition
$-$	Subtraction
$*$	Multiplication
$/$	Division
^	Exponentiation

- Some examples:
  - `>> 1 + 2`

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  - `>> 4/3 - 3/4 + 2^3`

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  - `>> 2^3/2`

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  - `>> 15/((2 + 3)*(4 - 1))`
  - `>> 2^3/2`
  - `>> 2^(3/2)`
- Use parentheses to enforce the desired order

Outline

All Matrices!

- "Everything" in MATLAB is a matrix
  - A *scalar* is a `1-by-1` matrix
  - A 1D array of *n* elements can be a `n-by-1` (row vector) or a `1-by-n` (column vector) matrix
  - A *string* of *n* characters is a `1-by-n` matrix
  - ...
- Some MATLAB *classes*:
  - `double` (Double-precision floating-point number array) (default)
  - `single` (Single-precision floating-point number array)
  - `char` (Character array)
  - `cell` (Cell array)
  - `struct` (Structure array)
  - `function_handle` (Array of values for calling functions indirectly)

Scalar Variables: `1-by-1` *Matrices*!

- Use the ‘=’ sign for *assignment*
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  - `>> sin(a)` % Sine of '`a`' = 0.8415

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  - `>> b = a + 2` % `b = 3`

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  - `>> b = a + 2` % `b = 3`
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- Use the commands `who` or `whos` to list the variables defined in the Workspace
- Other common functions are available: `exp`, `tan`, `sinh`, `acos`, ...

1D Arrays: Real Vectors (or *Matrices*!)

- Use `[...,...]` or `[... ...]` for *horizontal stacking* and `[...;...]` for *vertical stacking*
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  - `>> v8 = exp(v7)` % Element-wise operation

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  - `>> sz8 = size(v8)` % `= [1 3]`
  - `>> v9 = rand(1,5)` % Random `1-by-5` array

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  - `>> v9 = rand(1,5)` % Random `1-by-5` array
  - `>> p = prod(v1)` % Product of elements = 6

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- Use *horizontal stacking* and *vertical stacking* likewise
  - `>> m1 = [1 2 3; 4 5 6] % 2-by-3`

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  - `>> m2 = rand(2,3)` % Random `2-by-3` matrix

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  - `>> m3 = m1 + m2` % Matrix addition

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  - `>> m5 = m3/2` % Element-wise division

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  - `>> len4 = length(m4)` % Size of longest dimension
  - `>> m5 = m3/2` % Element-wise division
  - `>> m6 = tan(m5)` % Element-wise operation

Element-wise Operations

- The following are element-wise mathematical operators

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- More examples:
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  - `>> sprintf('Another large number = %g', rand*10^5)` % More compact format between `%e` and `%f`

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  - `>> quad(myfun,0,1)` % Adaptive Simpson quadrature to integrate ‘`myfun`’

Outline

M-Files

- The file with source code is called M-File (*.m)
- Scripts: No input and no output arguments. Contain a series of commands that may call other scripts and functions.
- Functions: Accept input and output arguments. Usually called program *routines* and have a special definition syntax.
- Inside scripts and functions you may use programming statements, such as flow, loop, and error control
- Open the Editor Window and start coding!

Function M-Files

- General form:

```
function [out1, out2, ...]  = funname(in1, in2, ...)
      statement
      ...
end % Optional
```

- Example:

```
function Z = virialgen(P,Pc,T,Tc,omega)
Pr = P/Pc;
Tr = T/Tc;
[B0,B1] = virialB(Tr);
Z = 1 + Pr/Tr*(B0 + omega*B1);

function [B0,B1] = virialB(Tr)
B0 = 0.083 - 0.422/Tr^1.6;
B1 = 0.139 - 0.172/Tr^4.2;
```

Code Cells

- Allow you to divide your M-files into sections (cells)
- Enable you to execute cell by cell
- Foundations for *publishing* your M-file to HTML, PDF, and other formats
- To begin a code cell, type `%%` at the beginning of a line
- The first line after the `%%` is the **title** of the code cell
- The next lines starting with `%` are a description of the code cell
- Place your code in the next lines
- A new code cell starts at the next `%%` at the beginning of a line

Code Cells: Example

- Simple example:

```
%% 99-999: Homework 1
% Bruno Abreu Calfa

%% Problem 1
x = linspace(0,1);
y = sin(x.^2).*exp(-x.*tan(x));
plot(x,y);

%% Problem 2
a = 0;
b = 1;
f = @(t) exp(-t.^2);
intf = quad(f,a,b);
sprintf('Integral of f from %g to %g = %g',a,b,intf)
```

Publishing your Code

- Saves output of your code to a specific file type
- Formats available:

File Format	**Description**
`doc`	Microsoft Word[1]
`latex`	LaTeX[1]
`ppt`	Microsoft Powerpoint[1]
`xml`	Extensible Markup Language
`pdf`	Portable Document Format
`html`	Hypertext Markup Language

- MATLAB evaluates your M-file and generates the output
- To publish your M-file, go to: File -> Publish

[1] Syntax highlighting not preserved