CME 192: Introduction to MATLAB

MATLAB Basics

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What is MATLAB?

- Computing & programming environment
- Visualization and mathematical prototyping tool
Why **MATLAB**?

Comparison with Other Languages

- **MATLAB** is an engineering prototyping language meant for ease of use with its vast mathematical resources.
- C is a low-level language meant for production-level performance.
- Other languages (e.g. Python) bridge the gap but do not have nearly the built-in mathematical capability.
Why **MATLAB**?

Comparison with C

- Suppose we want to multiply two matrices $A$ and $B$
- $AB$ is a new matrix where

$$(AB)_{ij} = \sum_{k=1}^{n} A_{ik} B_{kj}$$
Why MATLAB?
Comparison with C

- C code for matrix multiplication

```c
// Initialize matrix C to accumulate
// sum in each C[i][k]
for (i=0; i<I; i++)
    for (k=0; k<K; k++)
        C[i][k] = 0;

// matrix multiplication, C = AB
for (i=0; i<I; i++)
    for (j=0; j<J; j++)
        for (k=0; k<K; k++)
            C[i][j] += A[i][k] * B[k][j];
```
Why MATLAB?

Comparison with C

- MATLAB code for matrix multiplication

```matlab
1 C = A*B;
```
Goals

- We want to learn the syntax of MATLAB but we really want to understand how to exploit MATLAB’s abilities.
- Our goal: learn the “MATLAB Way” for accomplishing tasks.
Course Logistics: Lectures

- A laptop with MATLAB is recommended at each lecture.
- Check the course website for announcements. We will be posting lecture slides and assignments on the website. The url is http://www.stanford.edu/class/cme192/.
Course Logistics: Homework and Grading

- 3 assignments in total. The assignments will be posted on Thursday and due the following Thursday at 5PM.
- All assignments are mandatory. Instructions will be on the assignment and you will be submitting files to the Coursework dropbox.
- Grading is Satisfactory/No Credit. To get credit, you need to get at least 50 percent on each assignment.
Course Logistics: Office Hours

- There will be office hours held before class in this room starting at 1:45pm.
Course Logistics: Getting MATLAB

- See links on course webpage:
  http://stanford.edu/class/cme192/
Outline

MATLAB’s Graphic User Interface

Getting into MATLAB

Basic Computations
MATLAB’s Graphic User Interface
Default Layout

▶ Command Window
  ▶ The main window for executing commands
  ▶ MATLAB’s “sandbox”

▶ Command History
  ▶ The history of commands executed
  ▶ Useful for recalling commands
MATLAB’s Graphic User Interface
Default Layout

- **Current Folder**
  - The working directory for saving and loading files
  - MATLAB functions written by you need to be in this directory to work

- **Workspace**
  - A list of the currently defined variables
  - Data type and values are also displayed
MATLAB’s Graphic User Interface

Other Windows

- Editor
  - A text editor for writing and running scripts and functions
  - Also contains MATLAB’s Debugger
- Figure Window
  - An all-purpose visualization window for plotting of all kinds
  - 2-d plots, 3-d plots, surfaces, movies...
MATLAB’s Graphic User Interface

Other Windows

- MATLAB Help Browser and `help`
  - Contains almost everything you need to know about MATLAB
  - `help <function name>` gives you the usage information for MATLAB functions

- Variable Editor
  - Allows in-depth exploration and editing of variable entries
Getting into MATLAB

- In the Command Window, MATLAB can be used interactively.
- Tryout info, demo, help, helpbrowser, quit, clear, clc
- To store a value in a Matlab Session, or in a program, a variable is used.
- The Workspace window shows the variables that have been created.
- Variables can be created using an assignment statement. The format of the assignment statement is variablename = expression.
Help facilities

In principle all information about MATLAB can be found in MATLAB’s help facilities.
Below is the list of the most important ways to use the MATLAB help facilities:

▶ **Help Functions**: `help 'function name'` gives a short description of the function, the syntax, and other closely related help functions. If more extensive results are needed, try the command `doc`.

▶ **look for**: `lookfor 'topic'` gives the list of all possible function names which contain the specific search word.

▶ **Help Browser**: contains different ways to obtain the correct information, like lists, a global index and a search function.
Interrupting a running program/command

- To interrupt a running program, press Ctrl+c.
- If you inadvertently enter an infinite loop, this is the only way to stop your program.
Variables are an example of *identifier names*. The rules for *identifier names* are:

- The name must begin with an alphabet. After that, the name can contain letters, digits and underscore character but cannot have a space.
- There is a limit to the length of the name; the built-in function `namelengthmax` tells how many characters this is.
- **MATLAB** is case-sensitive.
- Cannot use *reserved words* for variable names.
- Names of built-in functions cannot be used for variable names.
Expressions

- Expressions can be created using values, variables that have already been created, operators, built-in functions, and parentheses.
- Long expressions can be continued on to the next line by typing three (or more) periods: *ellipses*.
- The *format* command can be used to specify the output format of expressions.
- The default in MATLAB is to display up to four decimal places.
- Try out *format short*, *format long*, *format short e*.
- The *format* command can also be used to control the spacing between MATLAB command and the result.
- Try out *format loose*, *format compact*. 
Numbers and arithmetic operations in MATLAB

There are three kinds of numbers used in MATLAB: integers, real numbers and complex numbers. Integers are entered without a decimal point.

1 EDU>> a = 10
2 a =
3 10

Variables realmin and realmax denote the smallest and the largest positive real numbers in MATLAB.

1 EDU>> realmax
2 ans =
3 1.7977e+308
4 EDU>> realmin
5 ans =
6 2.2251e−308
Numbers and arithmetic operations in `MATLAB`

Complex numbers in `MATLAB` are represented in rectangular form. The imaginary unit $\sqrt{-1}$ is denoted either by $i$ or $j$.

```
EDU>> i
ans =
0 + 1.0000i
```

In addition to classes of numbers mentioned above, `MATLAB` has three variables representing the nonnumbers: $-\text{Inf}$, $\text{Inf}$, $\text{NaN}$.
Basic Computations

Arithmetic

- The Usual Suspects
  - Addition (+), Subtraction (−), Multiplication (∗), Division (/), Exponentiation (^)

- Trig Functions
  - sin(), cos(), tan(), asin(), acos(), atan()

- Exponential Functions
  - exp(), log()
Basic Computations
...and More

- Complex Functions
  - `abs()`, `conj()`, `imag()`, `real()`
- Rounding Functions
  - `round()`, `floor()`, `ceil()`, `mod()`
- Order of Operations as usual
  - \((x(y + z))^2 \Rightarrow (x*(y+z))^2\)
- You name it, MATLAB’s got it
Exercises

- Run “help help” in the command window and examine the output.
- Create a variable, \textit{myage}, and store your age in it. Subtract one from the value of the variable. Add two to the value of the variable.
- Find a \texttt{format} option that would result in the following output format:

```matlab
1  EDU>>  5/16 + 2/7
2  ans =
3       67/112
```
Exercises

- Compute $2 + 3$, $2 \times 3$, $2/3$, $2^3$, $2^{1/3}$, $\log_2 3$, $\cos(3) \sin(3)$, $\sin(2 + 3)$, $\sqrt{-i}$ in the command line.

- The function $\sin$ calculates and returns the sine of an angle in radians. Use `help elfun` to find the name of the function that returns the sine of an angle in degrees. Verify that calling this function and passing 90 degrees to it results in 1.

- What is wrong with the following sequence of commands? Find the mistakes and correct them.
  1. $\sin (2x) - \tan x$
  2. $\pi^2 + e^2$
  3. $2 \text{and} 1 = 3$
  4. variable one $= 1$