CS 1112 Introduction to Computing Using MATLAB

DR. CURRAN MUHLBERGER

WWW.CS.CORNELL.EDU/COURSES/CS1112

Lecture 2: Programming basics

- Previous lecture & lab:
  - Intro to the course
  - “Computational senses”
  - Running commands and programs in Matlab
- Today:
  - Anatomy of a program
  - Variables, assignment, mathematical operations
  - Functions for input & output

- Announcements:
  - Set up folders on your PC, flash drive, or cloud storage to store code for class (see website)
  - See website for office hours and consulting hours
  - See Discussions for partner-finding tips (including WICC social tonight!)
  - First exercise due Sun evening
  - First project will be posted after Tue lecture

Formula

- Surface area of a sphere?

$$A = 4\pi r^2$$

- Have the cosine of some angle θ in [0, π/2] and want cos(θ/2)?

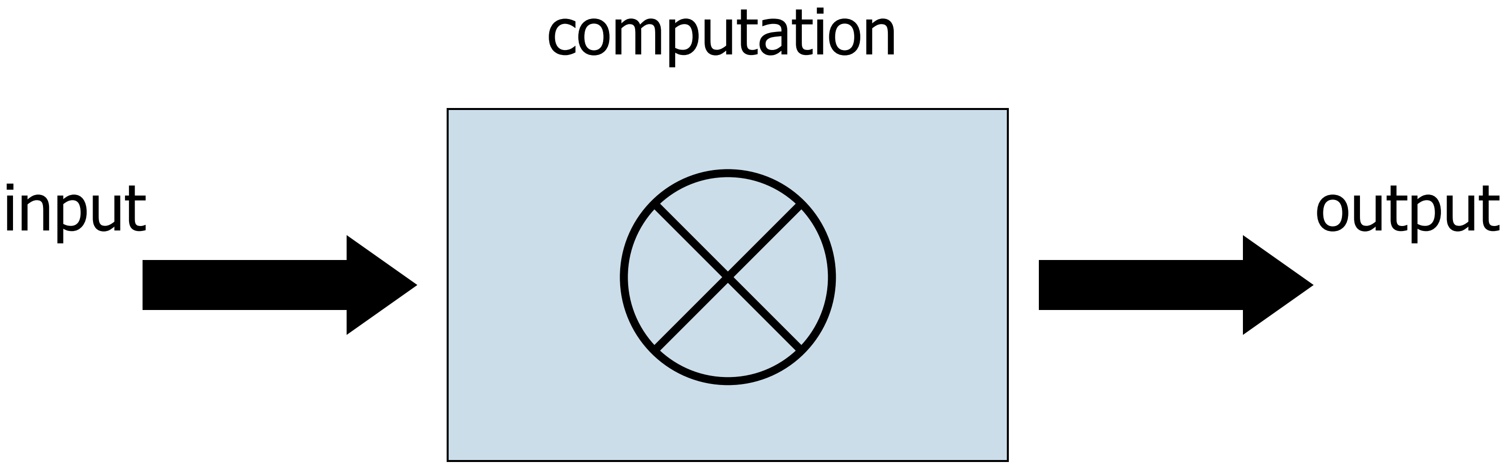
$$\cos(\theta/2) = \sqrt{\frac{1+\cos(\theta)}{2}}$$

Interactive computation in *Command Window*

```
>> r= 6

r =

     6

>> a= 4*pi*r^2

a =

  452.3893

>> v= 4/3*pi*r^3

v =

  904.7787
```

```
% Example 1_1:  Surface area of a sphere
% r: radius of the sphere [unit]
% A: surface area of the sphere [unit^2]

r= input('Enter the radius: ');
A= 4*pi*r^2;
fprintf('Surface area is %f units^2!\n', A)
```

A computer program



Where does computation happen?

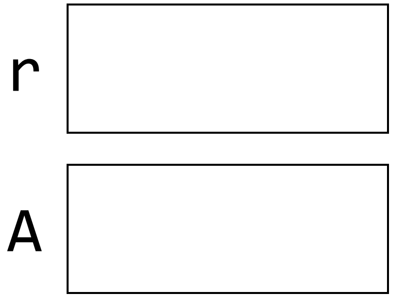
- Code lives on a disk (hard drive)
  - Matlab: Folder pane

- Variables live in memory (RAM)
  - Matlab: Workspace pane

Evan-Amos CC BY-SA

Variable & assignment

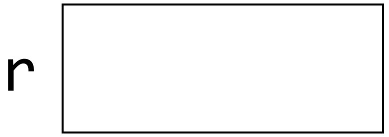
- Variable: a named computer memory space for storing a value



- Valid names start with a letter, can contain digits
- Use meaningful variable names!
- Create a variable by assigning a value to it
- By default, a number has the type (class) double, for “double precision floating point number”

Variable & assignment

- Variable: a named space for storing a value



- Assignment: putting a value into a variable
- Assignment operator: =
- An assignment statement, e.g., `r= 2*4.5`
- Expression on right-hand-side (rhs) is evaluated before the assignment operation
- Update variable’s value with another assignment statement, e.g., `r= 7`

Assignment

- Expression on rhs is evaluated before the assignment operation
- Examples:

```
x= 2*3.14
y= 1 + x
z= 4^2 – cos(y)
```

- Question: can we reverse the order of the 3 statements above?
- NO! Any variable on the rhs must be initialized.

Assignment

- Expression on rhs is evaluated before the assignment operation
- Examples:

```
x= 2*3.14
y= 1 + x
z= 4^2 – cos(y)
```

- Question: can we reverse the order of the 3 statements above?
- NO! Any variable on the rhs must be initialized.

Matlab's built-in functions

- Expression on rhs is evaluated before the assignment operation
- Examples:

```
x=  2*3.14
y=  1+x
z=  4^2  -  cos(y)
```

Function name

Argument (value) passed to the function

- Question: can we reverse the order of the 3 statements above?
- NO! Any variable on the rhs must be initialized.

Statements in a program are executed in sequence

```
% A program fragment ...
x= 2*3.14
y= 1 + x
x= 5
% What is y now?
```

A: 6

B: 7.28

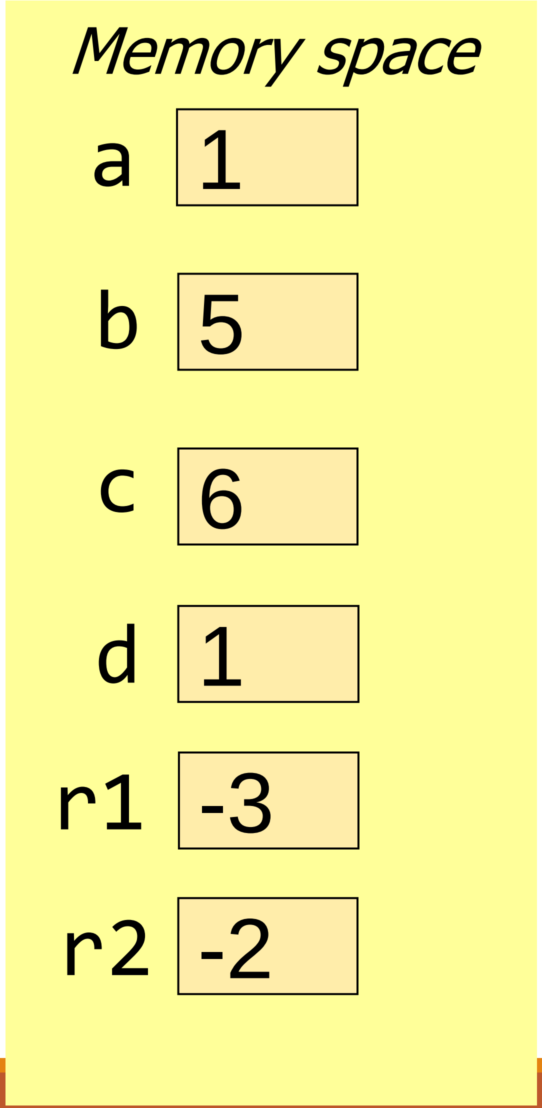
C: *some other value*

D: *error*

Script execution

(A script is a sequence of statements, an “m-file”)

```
% Quad1
% Solves x^2 + 5x + 6 = 0


  a  = 1;
  b  = 5;
  c  = 6;
  d  = sqrt(b^2 - 4*a*c);
  r1 = (-b - d)/(2*a)
  r2 = (-b + d)/(2*a)
```



Memory space

a	1
b	5
c	6
d	1
r1	-3
r2	-2

```
% Example 1_1:  Surface area of a sphere
% r: radius of the sphere [unit]
% A: surface area of the sphere [unit^2]

r= input('Enter the radius: ');
A= 4*pi*r^2;
fprintf('Surface area is %f units^2!\n', A)
```

Input & output

- *variable* = input('*prompt* ')

```
r= input('Enter radius: ')
```

- fprintf('*message to print* ')

```
fprintf('Increase ')
fprintf('is %f inches\n', x)
fprintf('Position (%d,%d)\n', x, y)
```

Substitution sequences (conversion specifications)

%f	fixed point (or floating point)
%d	decimal—whole number
%e	exponential
%g	general—Matlab chooses a format
%c	character
%s	string

During discussion: Found out how to control the number of decimal places shown with **`%f`**

```
% Example 1_1:  Surface area of a sphere
% r: radius of the sphere [unit]
% A: surface area of the sphere [unit^2]

r= input('Enter the radius: ');
A= 4*pi*r^2;
fprintf('Surface area is %f!\n', A)
```

Symbol to indicate that the rest of the line is a comment—not to be executed as code

Comments

- For readability!
- A comment starts with % and goes to the end of the line
- Start each program (script) with a concise description of what it does
- Define each important variable/constant
  - Units, assumptions/constraints
- Top a block of code for a specific task with a concise comment
  - Comment: "What we are trying to do"
  - Code: "How we are doing it"

Example

Modify the previous program to calculate the increase in surface area given an increase in the radius of a sphere.

Note: 1 mile = 5280 feet

```
% Example 1_2: Print surface area increase in
% miles^2 given an increase in the radius

r= input('Enter radius r in miles: ');
delta= input('Enter delta r in inches: ');
```

1 mile = 5280 feet

Tips for writing a program

- Check that you know what is given (or is input, or is assumed)
- Be goal-oriented: start by writing the last statement(s) for the program output
  - What is the program supposed to produce? *You know this from the problem statement*
  - Allows you to work backwards from the results
- Name as a variable what you don’t know
  - Helps you break down the steps
  - Allows you to temporarily skip over any part that you don’t know yet how to do

What’s next?

- So far, all the statements in our scripts are executed in order
- We do not have a way to specify that some statements should be executed only under some condition
- We need a new language construct…