L2. Basics

Variables and Expressions
Assignment Statements
Built-In Functions
Scripts
Comments
Keyboard Input
Formatting Output

Approach

Preview key concepts by first playing with Matlab as a calculator.

From formula to program.

Three Formulas

$A = 4\pi r^2$ — Surface Area of a Sphere

$\cos(x/2) = \sqrt{\frac{1+\cos(x)}{2}}$ — Half-Angle

$r = \frac{-b \pm \sqrt{b^2 + 4ac}}{2a}$ — Quadratic Equation

Surface Area Increase

```
>> r = 6365;
>> delta = .000001;
>> A_plus = 4*pi*(r+delta)^2;
>> A = 4*pi*r^2;
>> Increase = A_plus - A
Increase =
       0.15996992588043
```

Cosine(15 degrees)

```
>> c = cos(pi/3);
>> c = sqrt((1+c)/2);
>> c = sqrt((1+c)/2)
c =
   0.96592582628907
>> c15 = cos(pi/12)
c15 =
   0.96592582628907
```

$X^2 + 5x + 6 = (x+2)(x+3)$

```
>> a = 1;
>> b = 5;
>> c = 6;
>> d = sqrt(b^2 - 4*a*c);
>> r1 = (-b - d)/(2*a)
r1 =
    -3
>> r2 = (-b + d)/(2*a)
r2 =
    -2
```

Let's Revisit the Key Ideas Above and Introduce Others…

A Script

```
% 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)
```

Script

A sequence of instructions.

The order of the instructions is important.

A script is a program.

Comments

```
% 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)
```

Comments

Begin with the "%" symbol. Goes to the end of the line.

Facilitate the reading and understanding of the script.

Comments and Readability

Start each program (script) with a concise description of what it does

Define each important variable/constant

Top a block of code for a specific task with a concise comment.

Arithmetic Expressions

```
% 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)
```

Arithmetic Expression

A recipe that results in the production of a number.

Built-In Functions

```
% 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)
```

Built-In Functions

These are "packagings" of more advanced calculations.

Some examples: log, exp, sin, cos,…

Variables

```
% 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)
```

Variables

A variable is a "box" that holds a numerical value.

It has a name.

The name must begin with a letter.

Upper and lower cases are distinguished. Can use all letters and numbers and the underscore character.

Example: **`x1A_New`**

Assignment Statements

```
% 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)
```

Assignment Statements

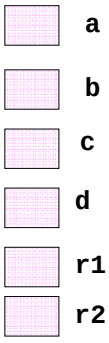
Variable Name = Arithmetic Expression

where to put it

a recipe for computing a numerical value

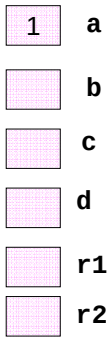
Script Execution

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



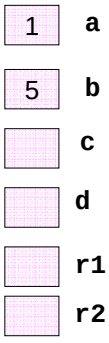
Script Execution

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



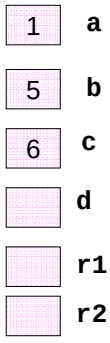
Script Execution

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



Script Execution

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



Script Execution

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

1	a
5	b
6	c
1	d
	r1
	r2

Script Execution

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

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

Script Execution

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

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

Remember…

Instructions are executed in order.

In assignment statements, the right hand side is evaluated first and then the value is assigned to the variable named on the left hand side.

The variables on the right hand side must have values before they can be used in an expression.

Question Time

What is the value of **X** and **Y** after the following script is executed:

```
X = 2;
Y = 7*X;
X = Y;
X = X + 1;
```

A. X is 5 and Y is 14
B. X is 15 and Y is 14
C. X is 5 and Y is 21
D. X is 15 and Y is 2

Question Time

What is the final value of **X** and **Y** ?

```
> X = 8;
> Y = X;
> X = Y;
> X = 2*X;
> Y = Y/2;
```

A. X is 16 and Y is 16
B. X is 8 and Y is 8
C. X is 16 and Y is 4
D. X is 8 and Y is 4

Another Script

```
% Quad2
% Solves ax^2 + bx + c = 0
% Assumes real roots.

a = input('Enter a: ');
b = input('Enter b: ');
c = input('Enter c: ');
d = sqrt(b^2 - 4*a*c);
r1 = (-b - d)/(2*a)
r2 = (-b + d)/(2*a)
```

The **input** Command

Variable Name = input(' Message');

where to put it

a prompt message in quotes

Processed after the user hits the <enter> key.

Formatting Output

When leaving off the semicolon isn't good enough.

The tools: **disp, fprintf**

disp

Displays a string.

Example:

```
disp('This is a message')
```

fprintf

Used to format output. Example:

```
X = 1.23456789;
fprintf('x = %5.2f\n',x))
```

Output line will look like

```
x =  1.23
```

The \n generates a carriage return

A Modification…

```
r1 = (-b - d)/(2*a)
r2 = (-b + d)/(2*a)
```

```
r1 = (-b - d)/(2*a);
r2 = (-b + d)/(2*a);

disp(' ')
fprintf('Root1 = %10.6f\n',r1))
fprintf('Root2 = %10.6f',r2))
```