Lecture5: User defined functions

Introduction

Algorithm

An **algorithm** is a sequence of steps needed to solve a problem.

- We will use MATLAB to develop algorithms to solve specific problems.
- The basic algorithm consists of 3 basic steps
  1. Get input(s)
  2. Calculate the result(s)
  3. Display result(s)

Scripts

- A script is a sequence of MATLAB instructions that are stored in a M-file and saved.
- Before creating a script, make sure the current folder is set to the folder in which you want so save your files
- To start a new script >>edit script1.m

input function

Objective: Take input from the user

- To call the input function - pass the prompt for input: If the expected input is a number

```
1              >>radius =input('Enter the radius:');
```

- If the expected input is a character or string of characters

```
1              >> letter=input('Enter a char:','s')
```

Output statements: disp

- Output statements display strings and/ or results of calculations.
- The simplest output function is disp

```
1                    >> disp('Hello World')
2                    Hello World
3                    >> disp(4^2)
4                         16
```

- disp will display the result of an expression or a string without assigning any value to ans.
- disp does not allow formatting.

Formatted output: `fprintf`

- Formatted output can be printed to the screen using `fprintf`.

```
1 >> fprintf('The answer is %d. \n',42)
2 The answer is 42.
```

- Specify decimal places for real numbers

```
1 >> x=2;
2 >> fprintf('The square root of %d is %.6f.\n',x,sqrt(x))
3 The square root of 2 is 1.414214.
```

- We can also specify field width

```
1 >> fprintf('The square root of %d is ...
    %20.6f.\n',x,sqrt(x))
2 The square root of 2 is              1.414214.
```

Formatted output: `fprintf`

- We can also specify field width

```
1  >> fprintf('The square root of %d is ...
      %20.6f.\n',x,sqrt(x))
2  The square root of 2 is             1.414214.
```

- If the field with is negative, the printing is left aligned

```
1  >> fprintf('The square root of %d is ...
      %-20.6f.\n',x,sqrt(x))
2  The square root of 2 is 1.414214            .
```

Formatted output: `fprintf`

- We can also print vectors or matrices

```
1  >> x = [0, 0.5, 1];
2  >> y = [x; exp(x)];
3  >> fprintf('%6.1e %12.4e\n',y);
4  0.0e+00    1.0000e+00
5  5.0e-01    1.6487e+00
6  1.0e+00    2.7183e+00
```

- And strings

```
1  >> fprintf('My string is %s! \n','Hello World')
2  My string is Hello World!
```

Formatted output: `fprintf`

- We pass to `fprintf` text to be printed and *conversion specifications* and expressions to be printed.
- Each conversion specification is introduced by a % character and ended by a letter

	The argument
d	is converted into decimal notation
c	is taken to be a single character
s	is a string
e	is converted into decimal notation of the form `m.nnnnnExx` where the length of n's is specified
f	is converted into decimal notation of the form `mmm.nnnnn` where the length of n's is specified

Special formats

Special character	Format specifier
Backspace	\b
New line	\n
Horizontal tab	\t

Additional options can be found (▸ here)

User defined functions

Scripts vs Functions

- All variables and parameters of a script are accessible in the workspace, i.e. externally accessible.
- This makes scripts good for testing and experimenting.
- In general, create a function to solve a given problem for arbitrary parameters.
- Use a script to run functions for specific parameters required.

Anatomy of MATLAB functions

A function returning a single result consists of the following:

- Function header (the first line), comprised of

  `function outputargument = functionname(input arguments)`

- Comments that describe what the function does (these comments will
  be printed when `help` is called)

- The body of the function that should manipulate the `inputvariable`
  and assign a value to the `outputvariable`

- `end` at the end of the function

Anatomy of MATLAB functions

```
1  function outputargument = functionname(input arguments)
2  %Comments that describe what this function does
3
4  Statements and computations
5  end % end of function
```

Programming Style Guidelines

- Make sure your comments describing functions or scripts contain useful information (e.g. how the function is called, expected output)
- Put a newline character at the end of every string printed by `fprintf`
- Suppress the output from all assignment statements in a function
- Functions that return a value do not normally print the value

Single input and output

Write a function to

- Compute the area of a circle of radius r.

Single input and multiple outputs

Write a function `stat` to

- Compute the average $\overline{x} = \dfrac{1}{n} \sum_{i=1}^{n} x_i$ and standard deviation

$$\sqrt{\frac{\sum_{i=1}^{n}(x - \overline{x})^2}{n}}.$$

WARNING - the functions `mean` and `std` already exist so do not use these as variable names otherwise MATLAB will not perform these functions.

Multiple inputs

Write a function that takes as input matrices x and y from meshgrid and a constant c and evaluates

$$f(x, y) = c \frac{\sin(\sqrt{x^2 + y^2})}{\sqrt{x^2 + y^2}}$$