INTRODUCTION TO PROGRAMMING IN MATLAB

Luigi Biagiotti

E-mail: luigi.biagiotti@unimore.it

http://www.dii.unimore.it/~lbiagiotti

Introduction

- The commands entered in the Command Window cannot be saved and executed again for several times. Therefore, a different way of executing repetitively commands with MATLAB is:
  1. **create a file** with a list of commands
  2. **save the file**
  3. **run the file**

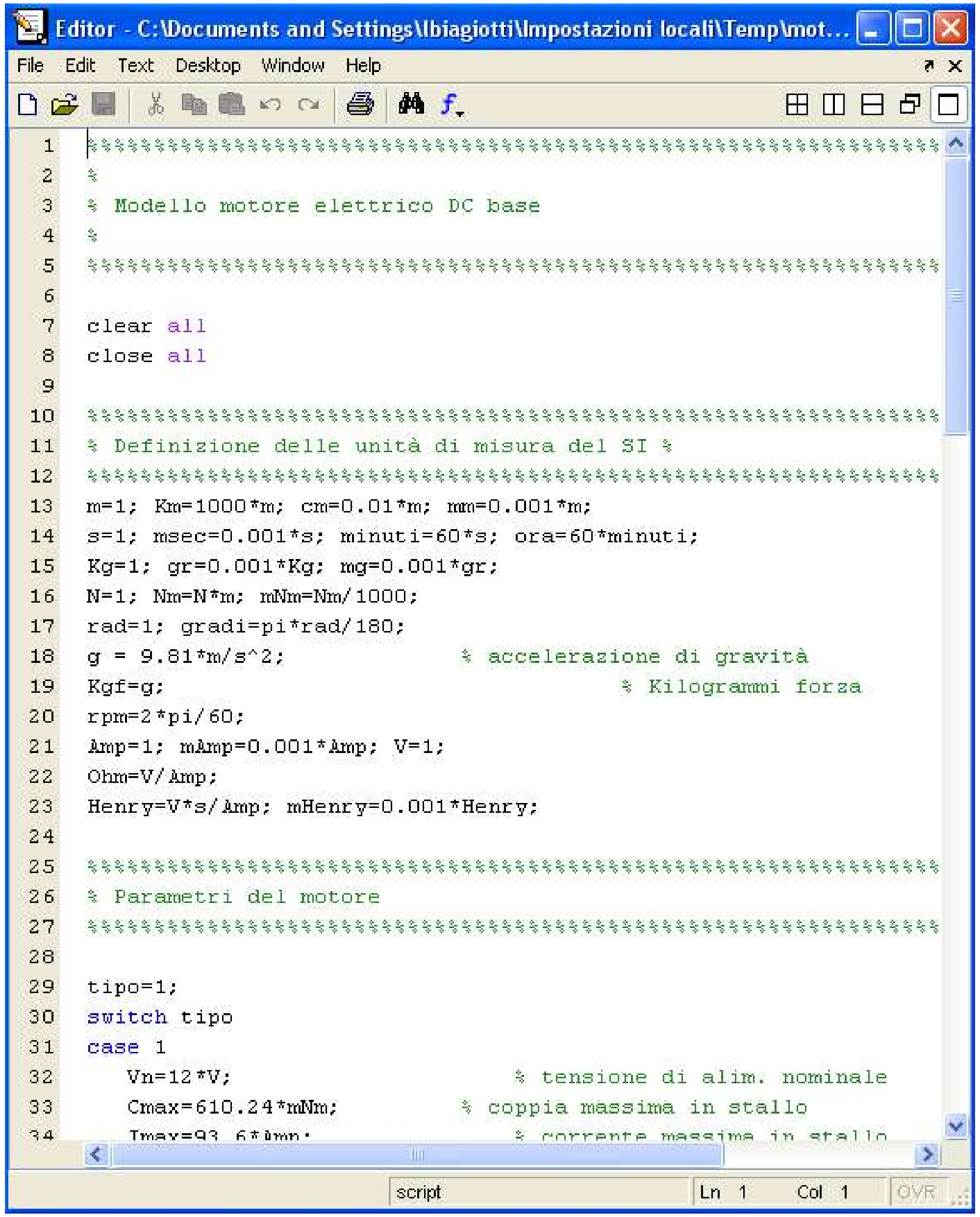
- MATLAB has a text editor specialized for creating M-files that can be opened with the command `>> edit` or `>> edit filename` to open (or create) the file filename.m

- MATLAB file can be ran by typing the name (without extension)

```
>> fileName <ENTER>
```

M-File Scripts

- A ***script file*** is an external file that contains a sequence of MATLAB statements (comments are preceded by %).
- Script files have a ***filename extension*** .m and are called M-files.
- M-files can be
  - *scripts* that simply execute a series of MATLAB statements
  - *functions* that can accept arguments and can produce one or more outputs.


Editor - C:\Documents and Settings\lbiagiotti\Impostazioni locali\Temp\mot...
File Edit Text Desktop Window Help
script
Ln 1 Col 1
OVR

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% Modello motore elettrico DC base
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all
close all

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Definizione delle unità di misura del SI %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
m=1; Km=1000*m; cm=0.01*m; mm=0.001*m;
s=1; msec=0.001*s; minuti=60*s; ora=60*minuti;
Kg=1; gr=0.001*Kg; mg=0.001*gr;
N=1; Nm=N*m; mNm=Nm/1000;
rad=1; gradi=pi*rad/180;
g = 9.81*m/s^2;             % accelerazione di gravità
Kgf=g;                                  % Kilogrammi forza
rpm=2*pi/60;
Amp=1; mAmp=0.001*Amp; V=1;
Ohm=V/Amp;
Henry=V*s/Amp; mHenry=0.001*Henry;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Parametri del motore
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

tipo=1;
switch tipo
case 1
   Vn=12*V;                         % tensione di alim. nominale
   Cmax=610.24*mNm;             % coppia massima in stallo
   Imax=93.6*Amp;                   % corrente massima in stallo
```

M-File Scripts

- By creating a file with the extension .m, we can easily write and run programs.
- We do not need to *compile* the program since MATLAB is an **interpretative** (not compiled) language.
- MATLAB has thousand of *functions*, and you can add your own using m-files.

M-file example

- Write a script for the solution of a linear system

$$\begin{cases} x_1 + x_2 + x_3 - x_4 = 1 \\ x_1 + x_2 - x_3 = 2 \\ x_1 - x_2 + x_3 = 0 \\ x_1 + 2x_2 - 3x_3 = 2 \end{cases}$$

- Solution (in the file LinearSystemScript.m)

```
A = [1, 1, 1, -1; 1, 1, -1, 0; 1, -1, 1, 0; 1, 2, -3, 0];
b = [1, 2, 0, 2]';
x = inv(A)*b;
```

Script side-effects

- **All variables created in a script file are added to the workspace**. This may have undesirable effects, because:
  - Variables already existing in the workspace may be overwritten.
  - The execution of the script can be affected by the state variables in the workspace.

M-functions

- Each M-function has **its *own* area of workspace**, separated from the MATLAB base workspace
- Structure of a M-function

```
function [Output]= FuncName(Input)
        % FuncName returns...
        % ...
        instructions;
                .
                .
                .
```

Function definition line (keyword **function**): it defines the function name, and number and order of input and output arguments

Description of the program, displayed when you request help

Function body: Program code that performs the actual computations

- **FuncName** must begin with a letter, and must be no longer than the maximum of 63 characters.
- **The name of the text file containing the function must be equal to the function name** with the extension .m

Control flow and operators

- Like other computer programming languages, MATLAB has some **decision making structures** for control of command execution. These *control flow* structures include *for loops*, *while loops*, and *if-else-end* constructions.

- Control flow structures are often in script M-files and M-function.

‘if…end’ structure

- MATLAB supports the variants of *if* construct:
  1. `if ... end`
  2. `if ... else ... end`
  3. `if ... elseif ... else ... end`
- Example (computation of the discriminant):

1.
```
discr = b*b - 4*a*c;
if discr < 0
disp('Warning: discriminant is negative, roots are
imaginary');
end
```

2.
```
discr = b*b - 4*a*c;
if discr < 0
disp('Warning: discriminant is negative, roots are
imaginary');
else
disp('Roots are real, but may be repeated')
end
```

'if...end' structure

- Example (computation of the discriminant):

3.
```
discr = b*b - 4*a*c;
if discr < 0
disp('Warning: discriminant is negative, roots are
imaginary');
elseif discr == 0
disp('Discriminant is zero, roots are repeated')
else
disp('Roots are real')
end
```

- Note that
  - elseif has no space between else and if (one word)
  - no semicolon (;) is needed at the end of lines containing if, else, end
  - indentation of if block is not required, but facilitate the reading.
  - the **end statement** is **required**

Relational and logical operators

- A relational operator compares two expressions by determining whether a comparison is *true* or *false* (**comparison is made element-by-element**). Relational operators are shown in the following table

Operator	Description
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to
==	Equal to
~=	Not equal to
&	AND operator
|	OR operator
~	NOT operator

The ‘for…end’ loop

- In the `for ... end` loop, the execution of a command is repeated at a fixed and predetermined number of times.
- The syntax is

```
for variable = expression
statements
end
```

  where `expression` is usually a vector of the form `i:s:j`

- Example: definition of a row vector

```
y=[];
for t=0:0.1:5
    y= [y t];
end
```

- Multiple for loops can be nested

The ‘while…end’ loop

- This loop is used when the number of *passes* is not specified. The looping continues until a stated condition is satisfied.
- The while loop has the form

```
while expression
statements
end
```

  where `statements` are executed as long as `expression` is true.
- Example

```
x = 1
while x <= 10
x = 3*x
end
```

- If the condition inside the looping is not well defined, the looping will continue *indefinitely*. If this happens, we can stop the execution by pressing **Ctrl-C**.