Computer Programming in MATLAB

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Computer is a device that computes, especially a programmable electronic machine that performs high-speed mathematical or logical operations or that assembles, stores, correlates, or otherwise processes information.

Computer Program is a set of ordered instructions that enable a computer to carry out a specific task.

Writing a computer program

1- Algorithm: step-by-step procedure for calculations
2- Choosing language: right language for program
3- Encoding

Languages:
- Scientific and engineering: MATLAB, Pascal, C, C++, Java
- Database: DBASE, SQL, FOXPRO, PARADOX
- Operating system: C, C++, Java
- General purpose: C, C++, Java, VB and Pascal
An algorithm is an effective method expressed as a finite list of well-defined instructions for calculating a function.

A set of instructions or procedures for solving a problem.
Let’s write an algorithm to calculate the sum of two numbers

**Step 1:** Start

**Step 2:** Enter X value

**Step 3:** Enter Y value

**Step 4:** Z = X + Y

**Step 5:** Print Z value

**Step 6:** End
Write an algorithm to calculate the mean of two numbers given.

**Step 1**: start

**Step 2**: enter X value

**Step 3**: enter Y value

**Step 4**: \( Z = X + Y \)

**Step 5**: \( \text{mean} = Z / 2 \)

**Step 6**: print mean

**Step 7**: end
An algorithm to calculate the area of a rectangle with given length. If the length of edge is defined as negative, it will be redefined.

Let’s define Variables:
First edge length of rectangle: a, Second edge length of rectangle : b, Area of rectangle: area

Algorithm:
S1 : start
S2 : enter a value
S3 : if a<0 repeat the second step
S4 : enter b value
S5 : if b<0, repeat the fourth step
S6 : area = a*b
S7 : print area value
S8 : end
Flow chart gives the logical flow of the solution in a diagramatic form.

- **Start / End**: Oval
- **Process Step**: Rectangle
- **Decision**: Diamond
- **Connector**: Arrow
Draw a flowchart to find the sum of numbers from 1 to 100

Algorithm:

S1 : Start
S2 : enter sum as zero
S3 : enter counter as zero
S4 : add counter to sum
S5 : add 1 to counter
S6 : if counter <100 then go to S4
S7 : print sum
S8 : End
Example 5

Draw a flowchart to find the root of the following first order equation, $Ax + B = 0$

Start

A = ?

A = 0

B = ?

$X = \frac{-B}{A}$

X

End
Example 6

Draw a flowchart to find the mean and sum of squares, square roots, cubes, squares of cubes of the numbers from 1 to 100.
Values of F(x) function depending on the x are as follows. X changes from 0 to 10 with the steps of 0.5. Draw the flowchart to calculate F(x) for each x values

0< X < 2  f(x)= X
2< X < 3  f(x)=X -X³ -22
3< X <4  f(x)=X² -2X+13
4< X  f(x)=X⁴ -3X² -43
Example 8

Draw a flowchart to find the largest of three numbers of A, B, and C.
Example 9

Draw a flowchart for computing factorial N (N!).

Start

Read N

M=1
F=1

F=F*M

M=M+1

Is M=N?

NO

YES

Print F

End
What is MATLAB

MATLAB is the acronym for MATrix LABoratory.

MATLAB, “the language of technical computing,” is a programming environment for algorithm development, data analysis, visualization, and numeric computation.

MATLAB:

- has a user-friendly interface,
- has many of scientific and mathematical function,
- provides a wide variety of techniques to display data graphically.
TOOLBOXES

MATLAB has a rich family of application-specific solution packages called toolboxes, which are comprehensive collections of MATLAB functions related to particular problems.

- Optimization Toolbox
- Control System Toolbox
- Neural Network Toolbox
- Fuzzy Logic Toolbox...
Some useful Links

www.mathworks.com
http://www.mathtools.net/
http://www.math.utah.edu/lab/ms/matlab/matlab.html
http://www.owlnet.rice.edu/~ceng303/manuals/matlab/index.html
http://web.cecs.pdx.edu/~gerry/MATLAB/masterOutline.html#intro
http://www.phon.ucl.ac.uk/courses/spsci/matlab/
Starting Matlab:

double click the Matlab icon

Command window and Matlab prompt >> (prompt is a symbol on the command window indicating that the matlab is waiting for an input.)

The MATLAB Help Window gives you access to a great deal of useful information about the MATLAB language and MATLAB computing environment. It also has a number of example programs and tutorials.

Quiting Matlab
- Type quit at the prompt, or
- Select Exit Matlab from the File menu
Atatürk University

**Introduction**

**MATLAB Screen**

- **Current Directory**
  - View folders and m-files

- **Command Window**
  - Type commands
  - Command window is where user interacts with MATLAB

- **Workspace**
  - View program variables
  - Double click on a variable to see it in the Array Editor

- **Command History**
  - View past commands
Matlab as a calculator

- Type expressions at the >>, and press return
- Result is computed, and displayed as ans
- Use numbers, +, -, *, /, sin, cos, exp, abs

```matlab
>> 2+5
ans =
   7
>> 3^2
ans =
   9
>> sin(pi/4)
ans =
   0.7071
>> 2*(2+3)
ans =
   10
>> 25^1/2
ans =
   5
>> 25^(1/2)
ans =
   5
>> 5*10/10*5
ans =
   25
>> 5*10/(10*5)
ans =
   1
```
### Use ( ) symbols as parentheses, {}, and [] mean something different.

### Example

\[
\frac{1}{2 + 3^2} + \frac{4}{5 \times \frac{6}{7}}
\]

In MATLAB, it becomes

\[
\begin{align*}
\text{>> } 1/(2+3^2) + 4/5*6/7 \\
\text{ans } &= \\
&= 0.7766
\end{align*}
\]

or, if parentheses are missing,

\[
\begin{align*}
\text{>> } 1/2+3^2+4/5*6/7 \\
\text{ans } &= \\
&= 10.1857
\end{align*}
\]
Matlab as a calculator

Introduction

- Previously entered commands can be recalled by dragging them from the command history to the command window or by pressing the up-arrow key, and then it can be edited.
- If a statement is terminated with a semicolon (;), no results will be displayed. Otherwise results will appear before the next prompt.
- If you omit the semicolon at the end of a line, that causes the assigned value to be printed on the screen.
- To clear command window, type clc and press enter.

```
>> 3+5
ans =
     8
>> 3+5;
>>
```
Variables in MATLAB

- Variables are named locations in memory where numbers, strings and other elements of data may be stored while the program is working.
- Variable names are used to assign the result of an expression to a variable.
- Variables do not need to be declared before assignment.

A single “equal” sign (=) is the assignment operator, LHS (left hand side)= RHS (right hand side)

Write the expression on the RHS, and assign the result to the variable named on the LHS (The left-hand-side needs to be a single variable name).

```
>> a=5
a =
    5
```

```
>> b=a+8
b =
    13
```
Rules for variable names

- Variable names are combinations of letters and numbers, but must start with a letter.

- All of the characters in variable names can not be the numbers.

- Variable names do not contain punctuation except underscore.

- Space between any characters in variable names can not be used. You can use underscore _ if you want a space.

- Matlab functions must not be used as variable names.

- Be sure to write the exact name of variable when you recall it. Because matlab is case sensitive for variable names. It distinguishes between uppercase and lowercase letters. So A and a are not the same variable.

- You should not use a MATLAB Function names (sin, cos, length, sqrt etc.). cos=5 changes cos function to a variable name.
Variable names

Introduction

Legal

\[
\begin{align*}
& \text{>> } x = 5; \\
& \text{>> } a = \sqrt{13}; \\
& \text{>> } b = \exp(2); \\
& \text{>> } a = 2*b \\
& \text{>> } a = a + 1 \\
& \text{>> } c = \tan(pi/4)
\end{align*}
\]

Illegal (all for different reasons)

\[
\begin{align*}
& \text{>> } d = \sqrt{E} + 1; \\
& \text{>> } 3 = E \\
& \text{>> } 3*a = 14 \\
& \text{>> } f = 2 \; 3
\end{align*}
\]
MATLAB utilizes the following arithmetic operators:

- addition
- subtraction
- multiplication
- division
- power operator
- transpose

We will use dot ‘.’ in front of these operators to make them element by element operators.
Commonly used Matlab functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Symbol</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine, ( \sin(\theta) )</td>
<td>( \sin )</td>
<td>( \sin(pi) )</td>
</tr>
<tr>
<td>Cosine, ( \cos(\theta) )</td>
<td>( \cos )</td>
<td>( \cos(pi) )</td>
</tr>
<tr>
<td>Tangent, ( \tan(\theta) )</td>
<td>( \tan )</td>
<td>( \tan(pi) )</td>
</tr>
<tr>
<td>Arcsine, ( \arcsin(\theta) )</td>
<td>( \text{asin} )</td>
<td>( \text{asin}(0) )</td>
</tr>
<tr>
<td>Arccosine, ( \arccos(\theta) )</td>
<td>( \text{acos} )</td>
<td>( \text{acos}(0) )</td>
</tr>
<tr>
<td>Arctangent, ( \arctan(\theta) )</td>
<td>( \text{atan} )</td>
<td>( \text{atan}(1) )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
<th>Symbol</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eksponential, ( e^x )</td>
<td>( \exp )</td>
<td>( \exp(2) )</td>
</tr>
<tr>
<td>Natural logarithm, ( \ln(x) )</td>
<td>( \log )</td>
<td>( \log(10) )</td>
</tr>
<tr>
<td>Common (base 10) logarithm</td>
<td>( \log_{10} )</td>
<td>( \log_{10}(10) )</td>
</tr>
<tr>
<td>Square root, ( \sqrt{x} )</td>
<td>( \text{sqrt} )</td>
<td>( \text{sqrt}(25) )</td>
</tr>
<tr>
<td>Absolute value, (</td>
<td>x</td>
<td>)</td>
</tr>
</tbody>
</table>
### Expressions suitable for Matlab

<table>
<thead>
<tr>
<th>Expression 1</th>
<th>Expression 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ab-c+d-6+da)</td>
<td>(a\times b-c+d-6+d\times a)</td>
</tr>
<tr>
<td>(b+c^3-d/8-b^2c)</td>
<td>(b+c^3-3-d/8-b^2\times2\times c)</td>
</tr>
<tr>
<td>(a + \frac{\sqrt{c^3} - bd^2 + \frac{2ab}{b^2 - 4ac}}{d + \frac{e - f}{3a}})</td>
<td>(\frac{a}{b} + c^{3/2} - b\times d^2 + (2\times a\times b)/(b^2 - 4\times a\times c))</td>
</tr>
</tbody>
</table>

???
### Mathematical Constants

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>eps</code></td>
<td>Floating-point relative accuracy</td>
</tr>
<tr>
<td><code>i</code></td>
<td>Imaginary unit</td>
</tr>
<tr>
<td><code>Inf</code></td>
<td>Infinity</td>
</tr>
<tr>
<td><code>intmax</code></td>
<td>Largest value of specified integer type</td>
</tr>
<tr>
<td><code>intmin</code></td>
<td>Smallest value of specified integer type</td>
</tr>
<tr>
<td><code>j</code></td>
<td>Imaginary unit</td>
</tr>
<tr>
<td><code>NaN</code></td>
<td>Not-a-Number</td>
</tr>
<tr>
<td><code>pi</code></td>
<td>Ratio of circle's circumference to its diameter</td>
</tr>
<tr>
<td><code>realmax</code></td>
<td>Largest positive floating-point number</td>
</tr>
<tr>
<td><code>realmin</code></td>
<td>Smallest positive normalized floating-point number</td>
</tr>
</tbody>
</table>
~ tilde
! exclamation mark
% per cent
^ wedge
& ampersand or and
* asterisk
( left parenthesis
) right parenthesis
_ underscore
- hyphen, minus or dash
= equals
+ plus
{ left brace (curly parenthesis)
}
right brace (curly parenthesis)
[ left bracket
] right bracket
| vertical bar
\ backslash
/ slash
? question mark
: colon
; semi-colon
" quote, quotation mark
' apostrophe, single quote
< less
> greater
, comma
. dot
* star
+ plus
Please write the following nice mathematical expression suitable for computer programming

\[ x = \frac{a + \frac{c}{b - a}}{\sqrt[3]{1 + c^2 - \sqrt{a + b^4}}} + (ac)^3 - \frac{\sqrt{a^4}}{2} \]
M-Files and Control statements ...