

Introduction to MATLAB

Part 2

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MatLab is a powerful computing language. Programming languages process data consisting of numbers, characters and strings and provide output, known as useful information. Data processing is carried out by executing a sequence of instructions called a computer program. This group of instructions or program is written by the user, using certain symbols and words according to syntax rules of a particular language.

MatLab also has its own vocabulary and grammar. We discuss concepts of character set, constants, variables, data types, operators and expressions in the lecture.

Any MatLab command that can be given at the command line can be used in an *M*-file. The MatLab has more features as compared to any other programming language.

It contains an extensive collection of functions that are available in many toolboxes like numerical algebra, control systems and neural networks.

The commonly used IF, WHILE and FOR loops of any programming language such as 'C' and 'PASCAL' can also be used in *M*-files for control flow, although there are slight differences in the syntax of these programming constructs.

MatLab is also equipped with powerful debugging features to locate and remove errors in *M*-files. The debugger provides a variety of useful functions such as breakpoint and line-by-line execution.

Character Set. The character set is a set of characters that form a part of the statements written using the programming language. Characters can be broadly classified into four categories :

- 1 Alphabets
- 2 Numerals
- 3 Special characters
- 4 White space characters

MatLab is case sensitive. Numerals 0 – 9 also form part of its character set. The special characters including the escape sequence characters form part of the character set. White space characters like tab, blank, new line, vertical tab and line-feed are also included in the character set.

Data Types. There are 14 fundamental data types (or classes) in MatLab. Each of these types is in the form of an array. This array is a minimum single element in size and can grow to an n -dimensional array of any size. Two-dimensional (2-D) versions of these arrays are called matrices.

Constants and Variables. Constants refer to fixed values which do not change during the execution of a program. Constants can be of two types:

- 1 Numeric constants
- 2 Character constants : Character constants can be single constants, string constants or escape sequence constants (for example, the symbol '\ b' means back space, '\ t' implies tab, '\ n' implies new line and so on.

Variables. Variables form an integral form of program in any language. The different types of data are identified by their names (variable names) for case in reference. Programming languages require a programmer to declare these variables and the type of data in advance at the beginning of the program, whereas no such declaration is required in MatLab.

MatLab does not require any variable or constant to be declared in advance at the start of a program. Blank spaces cannot be included in MatLab variable names. MatLab is case sensitive.

Operators. MatLab operators can be classified mainly into three categories :

- 1 Arithmetic operators that perform arithmetic computations like addition, multiplication, etc.
- 2 Relational operators that compare operands quantitatively like 'less than', 'not equal to', etc.
- 3 Logical operators that perform logical operations like AND, OR, NOT, etc.

Hierarchy of Operators. Generally several arithmetic operations are combined into a single expression. An expression is calculated by executing one arithmetic operation at a time (left to right).

The order in which the arithmetic operations are executed in an expression is called 'hierarchy of operations' or 'operator precedence'. The rules governing the precedence of operators generally follow the normal rules of algebra.

The order in which the arithmetic operations are executed are given as follows:

- 1 The contents of all parentheses () are evaluated first, starting from the innermost parentheses and working outwards.
- 2 Transpose, power, complex conjugate transpose, matrix power
- 3 Unary plus (+), unary minus (−), logical NOT ()
- 4 Multiplication, right division, left division, matrix multiplication, matrix right division, matrix left division
- 5 Addition and subtraction
- 6 Colon operator
- 7 Less than, less than or equal to, greater than, greater than or equal to, equal to and not equal to
- 8 Logical AND
- 9 Logical OR

Built-in Functions. A mathematical function is an expression which has one or more input values and gives one or more values as outputs. Engineering calculations require functions which are quite complex as compared to simple arithmetic expressions.

Examples of commonly used functions are trigonometric functions, logarithmic functions and input \ output functions.

Besides the simple arithmetic operations, a very large number and variety of useful built-in functions for complex engineering calculations related to all disciplines are available in MatLab. The list of built-in functions in MatLab is very large and richer than in most of the languages like FORTRAN or C. A complete list of all MatLab functions can be seen through help browser.

The syntax of a built-in function is

function name (variable name or expression)

Assignment Statement. General form of an assignment statement is given as follows:

variable name = expression ;

When an assignment statement is executed, the value of the expression to the right of the equality sign is first computed and the result obtained is assigned to the variable mentioned on the left of the equality sign.

List of Commands

abs	returns absolute number
any	returns true if any element of vector is non-zero
&	Finds logical AND
	finds logical OR
angle	returns phase angle in radians
all	returns True if all element of vector are non-zero
factorial	gives factorial of a number
pol2cart	converts polar to Cartesian coordinates
cart2pol	convert cartesian to polar coordinates
conj	gives conjugate of a complex number
real	returns real part of complex number
imag	returns imaginary part of complex number
log	gives natural logarithm
sqrt	returns square root of a number
tand	returns tangent of an angle given in degrees
xor	finds exclusive OR

- Misza Kalechman, "*Practical MATLAB Basics for Engineers*", CRC Press, London, 2009.
- Raj Kumar Bansal, Ashok Kumar Goel and Manoj Kumar Sharma, "*MATLAB and its applications in engineering*", Pearson, New Delhi, 2009.