

Unit 3. Matlab Syntax

3.1 Variables

3.2 Expressions

3.3 Fundamental data types

3.3 Operators

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Syntax

- The **syntax** of a language defines how to use keywords, operators, and variables to build and evaluate expressions.
- In this first part of the **Matlab Language syntax** we specify how to write the following elements:
 - Variables
 - Expressions

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Variables

- Some possible definitions:
 - “A symbol or name that stands for a value”
 - “A variable is a container which holds values”
 - “A variable is the name for a place in the computer's memory where you store some data.”
- A variable is a symbolic name given to an unknown data that permits the name to be used independently of the information that represents
 - Variables are associated with data storage locations

Values of a variable are normally changed during the

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Variables

- In MATLAB variables can be used:
 - In the command window
 - Within the code of a program
 - As parameters of functions
- We can **assign a value** of a variable, **retrieve its value** and **operate** with its value
- A variable is made of
 - Identifier/Name: list of characters used to reference the variable
 - Type: states the kind of values that will be stored in the

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Variables: naming a variable

■ Naming variables

- ❑ The names are case sensitive (*myvariable* and *myVariable* are different variables)
- ❑ The names should start by a letter followed by any combination of letters, digits and underscores
- ❑ Avoid using too long variable names
- ❑ Never use names of existing functions or MATLAB keywords (*break*, *case*, etc..). You can verify by using the function *'isvarname'*

Always use meaningful names

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Variables: assignment/creation statement

- It is used to set value to a variable.

variable = expression

- Examples:

guests = 20

vocal = 'a'

amount = 240.78 + 5

Note that this **equal sign** represents an **assignment** and not an arithmetic equality

You can modify the value of a variable as many times as you want

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Variables: retrieving its value

- The current value of a variable can be obtained writing the name of the variable in the command window. For example:

```
>> guest
```

```
guest = 20
```

```
>> vocal
```

```
vocal = a
```

```
>> amount
```

```
amount = 245.78
```

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Variables: retrieving its value

- As part of an expression:

- An expression is a construction composed by variables, values, operators and function calls
- MATLAB evaluates an expression and returns a value

- Examples:

```
>> guest * 5
```

```
ans = 100
```

```
>> (guest - 2) * 20
```

```
ans = 360
```

MATLAB evaluates the expressions from left to right. If the expression has not been explicitly assigned to a variable MATLAB automatically stores the result in the special

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Variables: type of variable

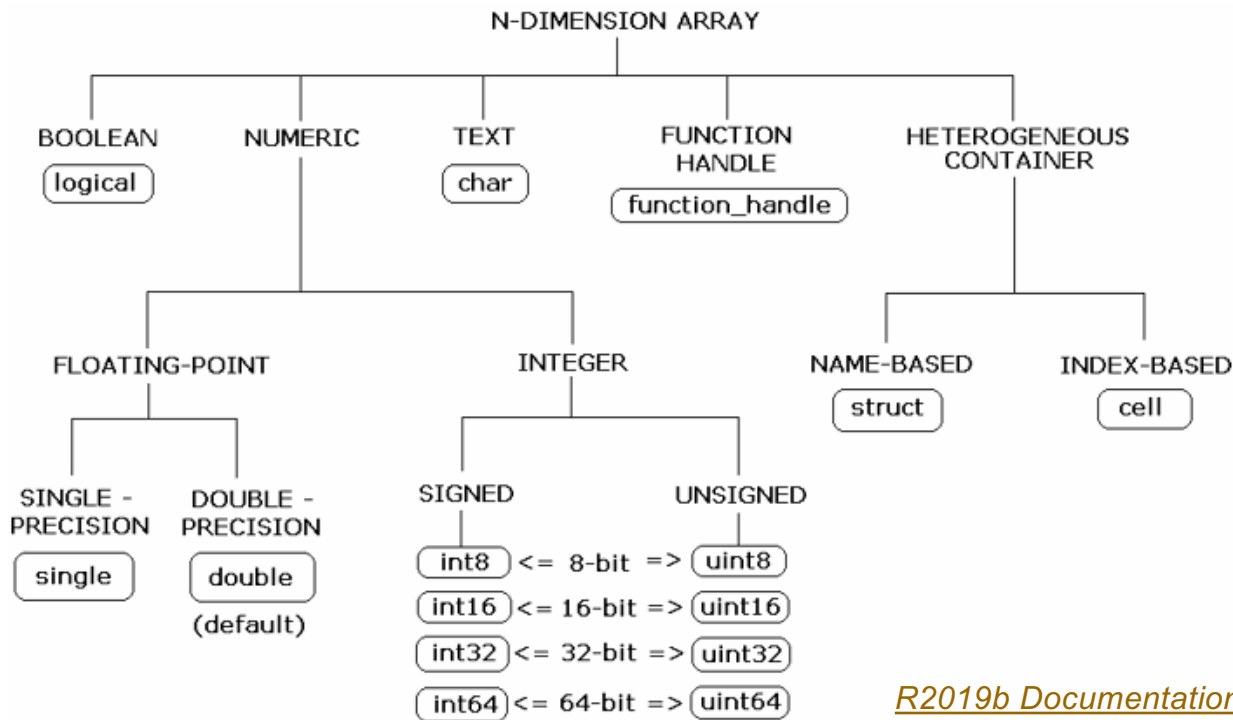
- A **type** restricts the values that a variable can include, **restricts the operation** supported by these values and **determines the meaning** of the operation.
- Matlab includes two categories of data types:
 - Fundamental data types: integers, chars, booleans..
 - User-defined types (MATLAB interface to java. *not*

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Fundamental data types



- There are 15 fundamental data types in MATLAB (lowercase in the diagram)

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Fundamental data types

- Boolean data types:

- **logical** : Represents a logical TRUE or FALSE state using the numbers 0 and 1. 0 represents FALSE and 1 represents TRUE

- Integers:

- **uint8, uint16, uint32, uint 64:** Unsigned integers. Size of 8,16, 32 and 64 bits respectively.

Ej: intmin(' uint8')

ans = 0

intmax(' uint8')

ans = 255

- **int8, int16, int32, int 64:** Signed integers. Size of 8,16, 32 and 64 bits respectively.

Ej: intmin(' int8')

ans = -128

intmax(' int8')

ans = 127

- Floating point numbers

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Fundamental data types

- **BY DEFAULT MATLAB STORES NUMERIC DATA AS DOUBLE.**

A = 56

- The type of A is double

To store the number as a different type you must specify it

A = int8(56)

- The type of A is int8

A = single(3.67)

- The type of A is single

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Fundamental data types

- Character data types:
 - **char** : Characters. Size 16-bits. Unicode.
 - TO SPECIFY THAT SOMETHING IS A CHAR YOU SHOULD PUT THE CHARACTER WITHIN **SINGLE QUOTATION MARKS**
 - Example: var = 'T'
 - Special type of array(vector) is a character string, it is a text surrounded by single quotes. Example: str = 'Hello'

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Fundamental data types

- Cells: Array of indexed cells, each capable of storing an array of a different dimension and data type.

$A = \{ \text{'Hello'}, 0.23, [0 \ 1 \ 2 \ 3] \}$

- Structures: provide the means to store hierarchical data together in a single entity by associating named fields to different information.

`s = struct('a', 'Hello', 'b', '0.23', 'c', [0 1 2 3]);`

`s.a`

`ans = 'Hello'`

`s.b`

`ans = 0.23`

`s.c`

`ans = 0 1 2 3`

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Variables: types

- In a strongly-typed programming language the datatype of the variable is defined as soon as the variable is declared.
- **Matlab is NOT strongly typed.** Variables don't need to be declared prior to use.
 - When MATLAB encounters a new variable name, it automatically creates the variable and assign a type based on the type of data is going to store.
 - When MATLAB encounters an assignment of an existing variable, the value and type that the variable

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Variables: declaration (creation)

- Example:

```
>> X = 50
```

```
>> Y = 'b'
```

```
>> X = -23.4
```

```
>> X = 'c'
```

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Variables: declaration (creation)

■ Example:

```
>> X = 50
```



MATLAB creates a variable X of type Double and stores the value 50

```
>> Y = 'b'
```



MATLAB creates a variable Y of type Char and stores the character b

```
>> X = -23.4
```



MATLAB stores the value -23.4 in the variable X

```
>> X = 'c'
```



MATLAB modifies the type of the variable X.
Now the variable has the type Char and stores

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Variables: declaration (creation)

- Be careful. You cannot operate with variables for which you haven't specify a value yet.

- Example:

```
>> A = 50
```

```
>> B = A * 2
```

```
>> C = A + D
```

What would be the answer from MATLAB to these commands?

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Variables: declaration (creation)

- Be careful. You cannot operate with variables for which you haven't specify a value yet.

- Example:

```
>> A = 50
```

```
A = 50
```

```
>> B = A * 2
```

```
B = 100
```

```
>> C = A + D
```

Error. Undefined function

MATLAB computes the value of B by replacing A in the expression for its current value (50)

The variable D has not been created previously. MATLAB cannot replace it by any

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Operators

- They are characterized by:
 - Numbers of operands (unary, binary, or ternary)
 - The type of operands (i.e. numeric or boolean)
 - The type of generated result

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Aritmetic Operators

- Aritmetic operators when working with variables with one single value (no matrices)

- + Addition
- - Subtraction
- * Multiplication
- / Division
- ^ Power

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Relational Operators

- Relational Operators

- < Less than
- <= Less than or equal to
- > Greater than
- >= Greater than or equal to
- == Equal to
- ~= Not equal to

- Example:

A = 7

B = 10

A > B

A < B

A == B

- Relational operators **compare values**

- The result is a boolean value:

- 0 when false
- 1 when true

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Logical Operators

- Logical operators:

- & and
- | or
- ~ not
- xor exclusive or

- For Matlab the 0 value corresponds to the logical value **False**, and any value different from 0 corresponds to **True**

A	B	A&B	A B	xor(A,B)	~A
0	0				
0	1				
1	0				

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Logical Operators

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- For Matlab the 0 value corresponds to the logical value **False**, and any value different from 0 corresponds to **True**

A	B	A&B	A B	xor(A,B)	~A
0	0	0	0	0	1
0	1	0	1	1	1
1	0	0	1	1	0

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Logical Operators

- Short-circuit operators

- && and
- || or

- Example:

A && B

if A equals zero returns zero

if A is not equals zero it evaluates B
and returns the correspondent value

- They work exactly in the same way as & and | , but they evaluate their second operand only when the result is not fully determined by the first operand

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Order of Operations

- Associativity ()
- Transpose, Power: $'$, $^$, $'$, $^$
- Logical negation: \sim
- Multiplication, division: $*$, $/$, \backslash , $.*$, $./$, $.\backslash$
- Addition, subtraction: $+$, $-$
- Colon: $:$
- Less, greater, equal: $<$ $>$ $<=$ $>=$ $==$ $\sim=$
- Element wise And: $\&$
- Element wise Or: $|$
- Short circuit And: $\&\&$
- Short circuit Or: $||$

Example:
 $2+3*5 == 17$
 $(2+3)*5 == 25$

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My first Matlab program

- Exercise: We want to create a program to automatically obtain the shopping list for our party
 - *Number of bags of ice cubes will be obtained by dividing the number of guests by 4*
 - *Number of pizzas will be obtained by dividing the number of guests by 3*
 - *Number of cans of coke will be obtained by multiplying*

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My first Matlab program

- Exercise: We want to create a program to automatically obtain the shopping list for our party
 - *Solution (using what we know so far...)*
 - *We are going to store the number of guest in a variable*
 - *Then we are going to perform operations with the variable to obtain the number of ice bags, cans of coke and pizzas*

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My first MATLAB program

- **Creating the source file:**

- The source should include the MATLAB language code.
- A text editor can be used to create and edit the source files.
- The extension of the file should be .m

- **Running the program:**

- Type the name of the file in the command window.
- The program should be placed in the current directory or in any directory of the variable *path*

Remember: You do not need to explicitly compile the program.
Since MATLAB is an interpreted language the compilation is carried

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My first Matlab program

■ Solution:

File name: shoppingList.m

guests = 20

guests / 4

guests / 3

*guests * 4*

Execution of the program

Command line:

>> run shoppingList

guest = 20

ans = 5

ans = 6.6667

ans = 80

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My first Matlab program

■ Solution:

File name: shoppingList.m

guests = 20

guests / 4

guests / 3

*guests * 4*

Execution of the program

Command line:

>> run shoppingList

guest = 20

ans = 5

ans = 6.6667

ans = 80

It's ok but we have to modify the program each time

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User keyboard input

- The command for asking the user to introduce some data via the keyboard during the execution is input.

- For numerical inputs (you want the user to introduce a number)

variableName = input('any sentence')

- For character inputs (you want the user to introduce a character)

variableName = input('any sentence ', 's')

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My first Matlab program

■ Solution:

File name: shoppingList.m

```
guests = input('Introduce the number of guests: ')
```

```
guests / 4
```

```
guests / 3
```

```
guests * 4
```

EXECUTION

Command line:

```
>> run shoppingList
```

```
Introduce the number of guests: 20
```

```
ans = 5
```

```
ans = 6.6667
```

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Exercise

- Exercise: Write a program named *converter* for changing euros to pounds. The exchange rate is: $1\text{€} = 0.799\text{£}$
- Example of execution:
Introduce a quantity: 5
ans = 3.9950

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Exercise

- Solution:

FILE: converter.m

```
euros = input('Introduce a quantity: ')  
euros * 0.799
```

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Exercise

- Exercise: Modify the *converter* program so it also asks the user to introduce the exchange rate
 - Example of execution:
Introduce a quantity: 5
Introduce the change rate: 0.799
ans = 3.9950

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Exercise

- Solution:

FILE: converter.m

```
euros = input('Introduce a quantity: ')  
change = input('Introduce the euros: ')  
euros * change
```

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Exercise

- Example of execution:

Introduce a quantity: 5

Introduce the change rate: 0.799

ans = 3.9950

Not an elegant way of displaying the result....
... the next week we will learn how to do it better

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Exercise

- Exercise: Write a program which asks the user to introduce two numbers and returns the sum of the two values
 - Example of execution:
Introduce a number: 8
Introduce another number: 2
ans = 10

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Exercise

- Solution:

number1 = input('Introduce a number: ')

number2 = input('Introduce another number: ')

number1 + number2

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Exercise

- Exercise: Modify the previous program so it asks two numbers and prints their sum. Next asks the user to introduce another number and divides the previous sum by it
 - Example of execution:
Introduce a number: 8
Introduce another number: 2
ans =10
Introduce another number: 2
ans = 5

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Exercise

- Solution:

FILE: division.m

```
number1 = input('Introduce a number: ')
```

```
number2 = input('Introduce another number: ')
```

```
mySum = (number1 + number2)
```

```
number3 = input('Introduce another number: ')
```

```
mySum / number3
```

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Exercises

1. Write a program that asks the user to introduce the coordinates x , y of two points and computes their distance
 - ❑ Remember the operator for power is $^{\wedge}$
 - ❑ To compute the square root use the MATLAB function ***sqrt(X)***
2. Write a program that asks the user to introduce an student's marks in five exams. The program should:

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Solutions

■ 1.- Solution

```
x1 = input('Introduce the x coordinate of the first point: ');  
y1 = input('Introduce the y coordinate of the first point: ');  
x2 = input('Introduce the x coordinate of the second point: ');  
y2 = input('Introduce the y coordinate of the second point: ');  
distance = sqrt((x1 - x2)^2 +(y1 - y2)^2)
```

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Solutions

■ 2.- Solution

```
m1 = input('Introduce the first mark: ');  
m2 = input('Introduce the second mark: ');  
m3 = input('Introduce the third mark: ');  
m4 = input('Introduce the fourth mark: ');  
m5 = input('Introduce the fifth mark: ');  
average = (m1+m2+m3+m4+m5) / 5
```

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