



DIGITAL SIGNAL PROCESSING LAB MANUAL 5

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MATLAB Fundamentals

Array Indexing

TASK

- Open New Script from Toolbar
- Write code (all examples and Exercises) in Editor Window
- Click Run from Tool Bar to see output in command window.
- Save all MATLAB Files in Separate folder called DSP Labs
- Write name of file: your group number and lab number. E.g., G2Lab3
- Click add to the path
- Check results (output)
- Submit MATLAB code to TA online. Solve each exercise in separate script.

Array Indexing

Every variable in MATLAB® is an array that can hold many numbers. When you want to access selected elements of an array, use indexing.

For example, consider the 4-by-4 magic square A:

```
A = magic(4)
```

```
A = 4x4
```

```
16     2     3    13
 5    11    10     8
 9     7     6    12
 4    14    15     1
```

There are two ways to refer to a particular element in an array. The most common way is to specify row and column subscripts, such as

```
A(4,2)
```

```
ans = 14
```

Less common, but sometimes useful, is to use a single subscript that traverses down each column in order:

```
A(8)
```

```
ans = 14
```

Using a single subscript to refer to a particular element in an array is called *linear indexing*.

If you try to refer to elements outside an array on the right side of an assignment statement, MATLAB throws an error.

```
test = A(4,5)
```

Index exceeds matrix dimensions.

However, on the left side of an assignment statement, you can specify elements outside the current dimensions. The size of the array increases to accommodate the newcomers.

```
A(4,5) = 17
```

```
A = 4×5
```

16	2	3	13	0
5	11	10	8	0
9	7	6	12	0
4	14	15	1	17

To refer to multiple elements of an array, use the colon operator, which allows you to specify a range of the form start:end. For example, list the elements in the first three rows and the second column of A:

```
A(1:3,2)
```

```
ans = 3×1
```

```
2
11
7
```

The colon alone, without start or end values, specifies all of the elements in that dimension. For example, select all the columns in the third row of A:

```
A(3,:)
```

```
ans = 1×5
```

```
9    7    6   12    0
```

The colon operator also allows you to create an equally spaced vector of values using the more general form start:step:end.

```
B = 0:10:100
```

```
B = 1×11
```

```
0    10    20    30    40    50    60    70    80    90   100
```

If you omit the middle step, as in start:end, MATLAB uses the default step value of 1.

Comments in MATLAB Code

Use % sign for comment.

ALL Code must be properly commented for submission, explaining each each step/line of exercises.

Exercise 1

Create Matrix Z

1	2	3
5	6	4
9	8	7

- Display all elements of 3rd row.
- Display all elements of 2nd column only.
- Display 2nd row only.
- Display 1st column only.
- Display element on 3rd row and 2nd column using row and column subscript.
- Display element on 2nd row and 2nd column using row and column subscript.
- Display element on 1st row and 3rd column using row and column subscript.
- Display element on 3rd row and 2nd column using row and column subscript.
- Display element on 3rd row and 2nd column using linear indexing.
- Display element on 1st row and 2nd column using linear indexing.
- Display element on 3rd row and 1st column using linear indexing.
- Display element on 4th row and 1st column.
- Add new element 10 on 4th row and 1st column.
- Add new element 20 on 1st row and 4th column.
- Add new element 30 on 4th row and 3rd column.

Exercise 2

- Create an equally spaced matrix (vector) of 1 row and 5 columns, named A, starting from 0 and taking step of 20.
- Create an equally spaced matrix (vector) of 1 row and 10 columns, named B, starting from 5 and taking step of 5.
- Create Matrix W of size 5*5 using function magic,
 - display first 3 columns only.
 - display 2nd, 3rd and 4th row only.

Challenge:

c. Display 2nd and 5th row of Matrix T in Matrix X.

- Create Matrix T of size 7*7 using function magic,

- a. display first 5 columns only.
- b. display first 3 rows only.
- c. display 2nd, 3rd and 4th row only.
- d. display 4th to 7th columns only.
- e. display last 3 rows only.
- f. display last 2 columns only.

Challenge:

g. Display 2nd, 4th and 7th column of Matrix T in Matrix Y.

Workspace Variables

The *workspace* contains variables that you create within or import into MATLAB® from data files or other programs. For example, these statements create variables A and B in the workspace.

```
A = magic(4);
B = rand(3,5,2);
```

You can view the contents of the workspace using whos.

```
whos
```

Name	Size	Bytes	Class	Attributes
A	4x4	128	double	
B	3x5x2	240	double	

The variables also appear in the Workspace pane on the desktop.



Workspace variables do not persist after you exit MATLAB. Save your data for later use with the save command,

```
save myfile.mat
```

Saving preserves the workspace in your current working folder in a compressed file with a .mat extension, called a MAT-file.

To clear all the variables from the workspace, use the `clear` command.

Restore data from a MAT-file into the workspace using `load`.

```
load myfile.mat
```

Text and Characters

Text in String Arrays

When you are working with text, enclose sequences of characters in double quotes. You can assign text to a variable.

```
t = "Hello, world";
```

If the text includes double quotes, use two double quotes within the definition.

```
q = "Something ""quoted"" and something else."
```

```
q =
```

```
"Something "quoted" and something else."
```

`t` and `q` are arrays, like all MATLAB® variables. Their *class* or data type is `string`.

```
whos t
```

Name	Size	Bytes	Class	Attributes
t	1x1	174	string	

i Note

Creating string arrays with double quotes was introduced in R2017a. If you are using an earlier release, create character arrays. For details, see [Data in Character Arrays](#).

To add text to the end of a string, use the plus operator, `+`.

```
f = 71;  
c = (f-32)/1.8;  
tempText = "Temperature is " + c + "C"
```

```
tempText =  
"Temperature is 21.6667C"
```

Similar to numeric arrays, string arrays can have multiple elements. Use the `strlength` function to find the length of each string within an array.

```
A = ["a", "bb", "ccc"; "dddd", "eeeeee", "fffffff"]
```

```
A =  
2x3 string array  
"a"      "bb"      "ccc"  
"dddd"   "eeeeee"  "fffffff"
```

```
strlength(A)
```

```
ans =
```

```
1    2    3  
4    6    7
```

Data in Character Arrays

Sometimes characters represent data that does not correspond to text, such as a DNA sequence. You can store this type of data in a character array, which has data type `char`. Character arrays use single quotes.

```
seq = 'GCTAGAATCC';  
whos seq
```

Name	Size	Bytes	Class	Attributes
seq	1x10	20	char	

Each element of the array contains a single character.

```
seq(4)
```

```
ans =  
'A'
```

Concatenate character arrays with square brackets, just as you concatenate numeric arrays.

```
seq2 = [seq 'ATTAGAAACC']
```

```
seq2 =  
'GCTAGAATCCATTAGAAACC'
```

Character arrays are common in programs that were written before the introduction of string arrays. All MATLAB functions that accept string data also accept `char` data, and vice versa.

Exercise 3

1. Create Matrix A using random function and display its contents in workspace using `whos`.
2. Display a sentence telling your name and save it in variable name.

3. Display a sentence telling anything about you.
4. Use whos function for variable name.
5. Save length 10cm and width 5cm of a rectangle, now calculate its area on run time and display it, using + operator.
e.g. “area is 50 cm²”

(Read temperature example mentioned above carefully for reference)

6. Save radius of circle 5 cm, now calculate its circumference on run time and display it, using + operator.
e.g. “circumference is ____ cm”
7. Create a string array A and load following strings in it and display their lengths using function strlen.

Signal

Frequency

Computer Science

Digital Signal Processing

8. Save ‘FAISALABAD’ in a character array City and display its character placed on 4th position.
9. Save ‘Signal’ in a character array seq1 and display its character placed on 6th position.
10. Save ‘Processing’ in a character array seq2 and display its character placed on 9th position.

Challenge:

11. Concatenate seq1 and seq2 such that result will display like that:
‘Our course name is Digital Signal Processing’
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