Matlab-Matrix

tutorialspoint

SIMPLY EASY LEARNING

www.tutorialspoint.com

https://www.facebook.com/tutorialspointindia https://twitter.com/tutorialspoint

About the Tutorial

MATLAB is a programming language developed by MathWorks. It started out as a matrix programming language where linear algebra programming was simple. It can be run both under interactive sessions and as a batch job. This tutorial gives you aggressively a gentle introduction of MATLAB programming language. It is designed to give students fluency in MATLAB programming language. Problem-based MATLAB examples have been given in simple and easy way to make your learning fast and effective.

Audience

This tutorial has been prepared for the beginners to help them understand basic to advanced functionality of MATLAB. After completing this tutorial you will find yourself at a moderate level of expertise in using MATLAB from where you can take yourself to next levels.

Prerequisites

We assume you have a little knowledge of any computer programming and understand concepts like variables, constants, expression, statements, etc. If you have done programming in any other high-level programming language like C, C++ or Java, then it will be very much beneficial and learning MATLAB will be like a fun for you.

Copyright &Disclaimer

Table of Contents

About the Tutorial ii

Audience ii

Prerequisites ii

Copyright &Disclaimer ii

Table of Contents iii

1. MATLAB Matrix — Introduction 1

Referencing the Elements 2

2. MATLAB MATRIX — Environment Setup 6

Understanding the MATLAB Environment 8

3. MATLAB Matrix — Create a Matrix 11

Matrix with single row 11

Matrix with Multiple rows 11

4. MATLAB MATRIX — Working with Matrices 14

Using Command Prompt 14

Using m-file 15

5. MATLAB Matrix — Multiplication 17

The mtimes function 17

6. MATLAB Matrix — Addition 19

The plus() function 19

7. MATLAB Matrix — Subtraction 21

The minus() function 21

8. MATLAB Matrix— Matrix Determinant 23

9. MATLAB Matrix — Inverse 24

10. MATLAB Matrix — Trace 25

11. MATLAB Matrix — Rank 26

12. MATLAB Matrix — Transpose 27

The transpose() function 27

13. MATLAB Matrix — Deletion of Row and Column 29

1. MATLAB Matrix — Introduction

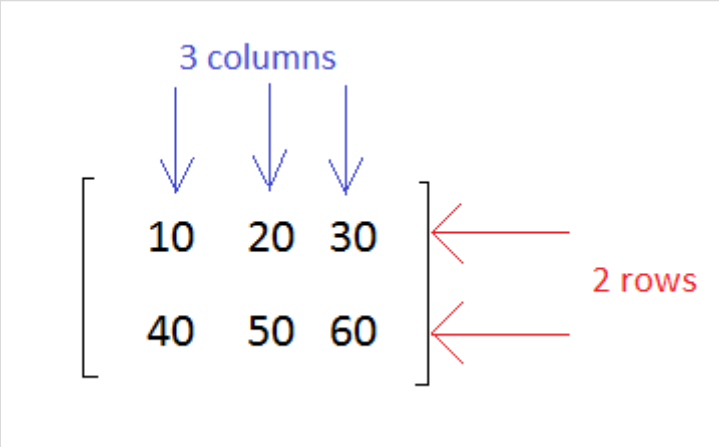
MATLAB (matrix laboratory) is a fourth-generation high-level programming language and interactive environment for numerical computation, visualization and programming. It allows matrix manipulations; plotting of functions and data; implementation of algorithms; creation of user interfaces; interfacing with programs written in other languages, including C, C++, Java, and FORTRAN; analyze data; develop algorithms; and create models and applications.

In this tutorial we will focus on Matrix Implementation using MATLAB.

Matrix

A matrix is a collection of numbers arranged in rows and columns that represents a rectangular array.

An example of matrix with 2 rows and 3 columns is as shown below:



Matrix Dimension

The dimension of a matrix is defined based on the number of rows and columns.

A matrix with 2 rows and 3 columns is said to be 2x3 matrix.

A matrix with 3 rows and 3 columns is said to be 3x3 matrix.

Matrix in Matlab

In MATLAB, you create a matrix by entering elements in each row as comma or space delimited numbers and using semicolons to mark the end of each row.

To create a 4x5 matrix, enter the following:

```
a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]
```

The matrix has 4 rows and 5 columns.

The first row will have values as 1 2 3 4 5

The second row: 2 3 4 5 6

The third row: 3 4 5 6 7

The fourth row: 4 5 6 7 8

The matrix of size 4x5 will look as follows:

```
a =  1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8
```

Let us test the matrix creation in MATLAB command window as shown below:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]

a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8

>>
```

Referencing the Elements

To reference an element in the mth row and nth column, of a matrix mx, we write the following:

```
mx(m, n);
```

Example

To refer to the element in the 2nd row and 5th column, of the matrix a, as created in the last section, we type the following:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]

a =

     1     2     3     4     5
     2     3     4     5     6
```

```
     3     4     5     6     7
     4     5     6     7     8

>> a(2,5)

ans =

     6

>>
```

To get all the elements of the nth column in a matrix , you can make use of A (:,n) where n represents the column no in the matrix.

```
A(:,n).
```

Now, let us create a column vector v, from all the elements of the 4th column of the matrix a. This will be as follows:

```
a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8];
v = a(:,4)
```

MATLAB will execute the above statement and return the following result:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]

a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8

>> v=a(:,4)

v =

     4
     5
     6
```

```
     7


>>
```

You can also select the elements in the mth through nth columns. For this, we write as follows:

```
a(:,m:n)
```

Let us create a smaller matrix by taking the elements from the second and third columns, as shown below:

```
a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8];
a(:, 2:3)
```

MATLAB will execute the above statement and return the following result:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]

a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8

>> a(:, 2:3)

ans =

     2     3
     3     4
     4     5
     5     6

>>
```

In the same way, you can create a sub-matrix by taking a sub-part of a matrix.

Example

Let us create a sub-matrix saby taking the inner subpart of a, as given below:

```
3     4     5
4     5     6
```

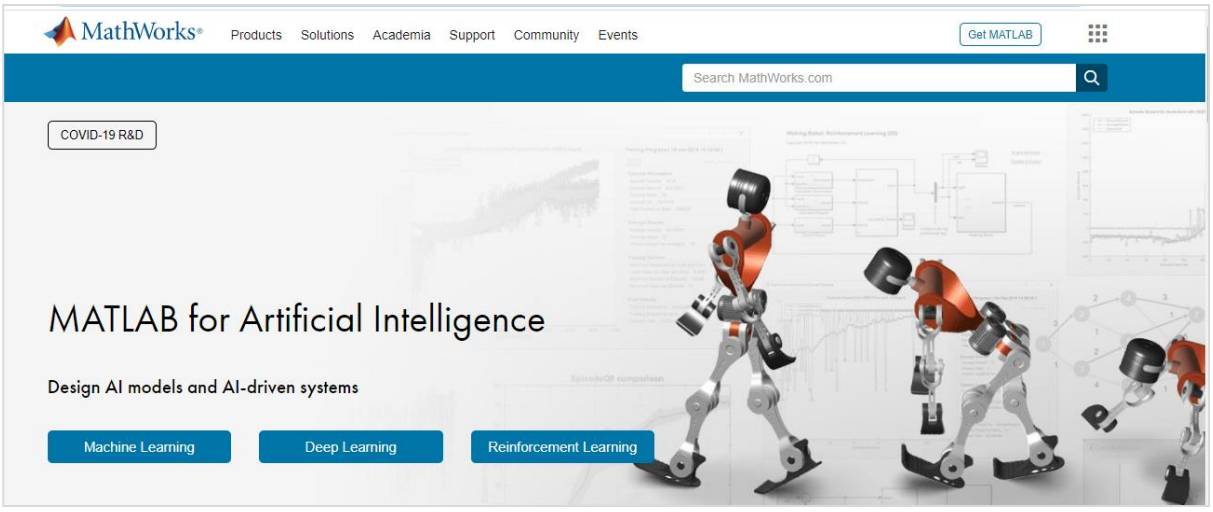
During execution in MATLAB command window, the matrix will be as shown below:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]

a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8

>> sa = a(2:3,2:4)

sa =

     3     4     5
     4     5     6

>>
```

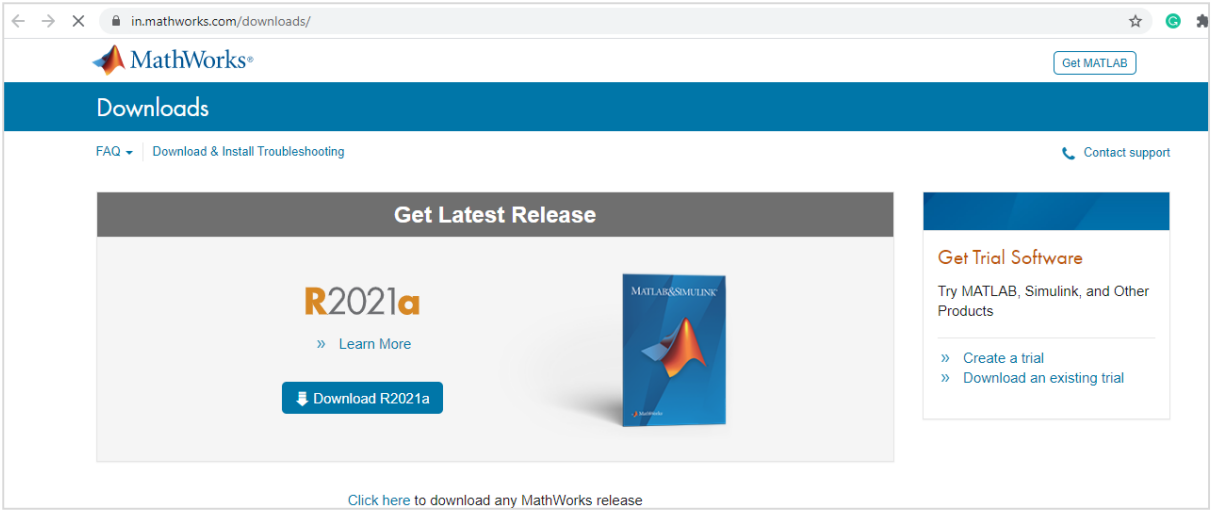
2. MATLAB MATRIX — Environment Setup

The official website of MATLAB is https://www.mathworks.com/.

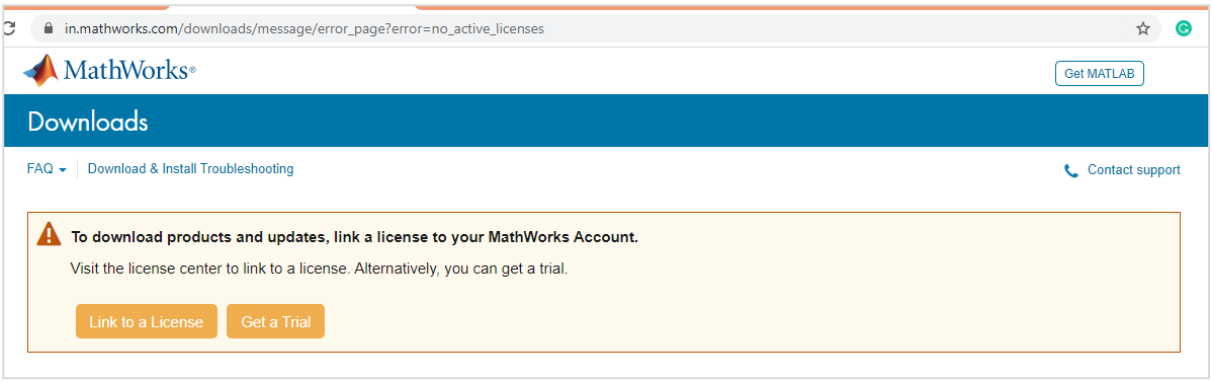
The following page will appear on your screen:



To download MATLAB go tohttps://in.mathworks.com/downloads/ as shown below:



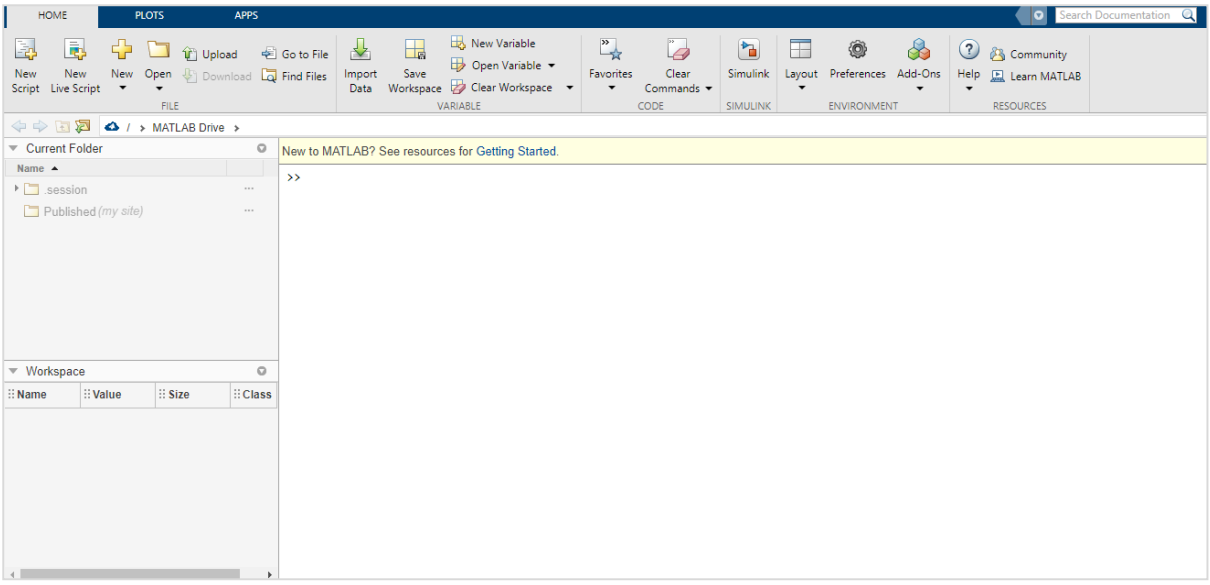
MATLAB is not free to download and you need to pay for the licensed copy. Later on you can download it.



A free trial version is available for which you have to create a login for your respective account. Once an account is created, they allow you to download MATLAB and also an online version for a trial of 30 days' license.

Once you are done with the creating a login from their website, download MATLAB and install on your system. Then, start MATLAB or you can also make use of their online version that will be available once you sign in.

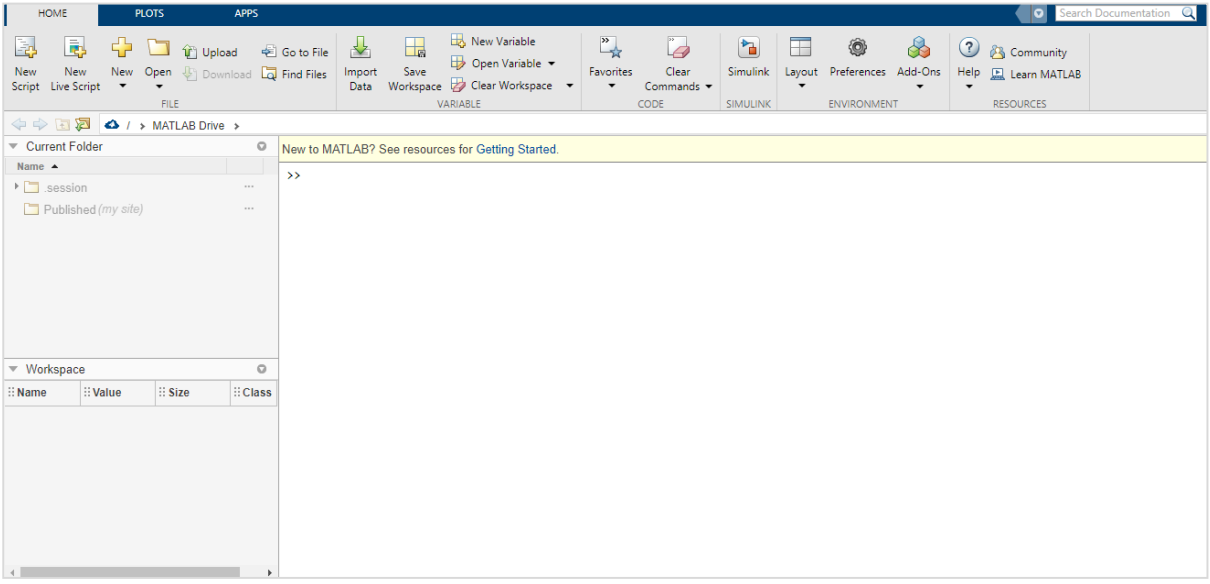
This is how the UI interface of MATLAB looks like when you install matlab or hit the online link of MATLAB.



Understanding the MATLAB Environment

MATLAB development IDE can be launched from the icon created on the desktop. The main working window in MATLAB is called the desktop. When MATLAB is started, the desktop appears in its default layout.

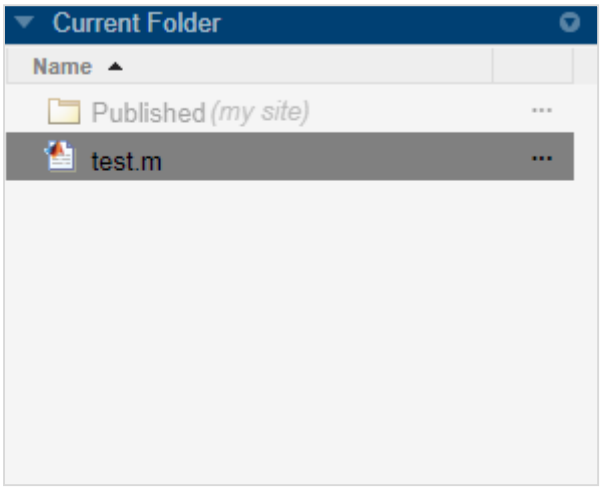
As I said earlier if you are using the trial version can make use of the online link of MATLAB to get the IDE as shown below:



Let us understand the MATLAB IDE.

Current Folder

This panel allows you to access the project folders and files.



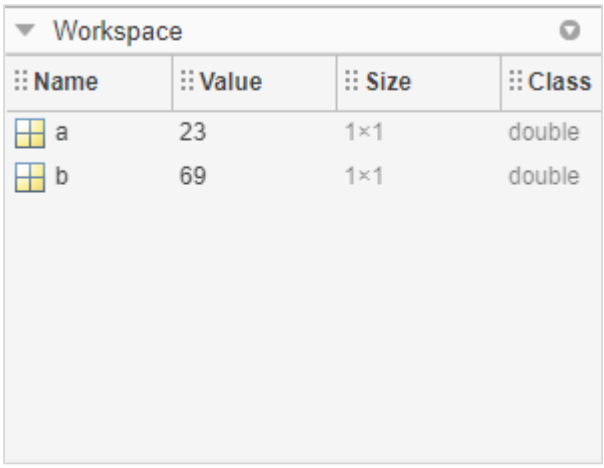
Command Window

This is the main area where commands can be entered at the command line. It is indicated by the command prompt (>>).

```
>> a=23

a =

    23

>> b=69

b =

    69

>>
```

Workspace

The workspace shows all the variables created and/or imported from files.



3. MATLAB Matrix — Create a Matrix

In MATLAB, you can create a matrix by entering the elements in each row as comma. You can also create a matrix with space delimited numbers and by using the semicolons to mark the end of each row.

Matrix with single row

Let us create a simple matrix in MATLAB that has a single row and three elements. Each element should have a space or comma.

Example

Consider the below mentioned elements to create a matrix.

```
m=[2, 4, 6];
```

On execution in MATLAB it will display the following:

```
>> m = [2, 4, 6]

m =

     2     4     6

>>
```

When you execute the code in MATLAB, the result of the matrix is displayed in the command window.

Matrix with Multiple rows

Let us now create a matrix with multiple rows. To do that, we need to separate each row with semicolon (;) as shown below:

```
m = [2 4 6; 3 6 9; 4 8 12];
```

Here **246** is the first row, 3 **6 9** is the second row and **4 8 12** is the third row. The matrix will be as follows:

```
m = 2     4     6
     3     6     9
     4     8    12
```

Let us now execute the same in MATLAB command prompt, as mentioned below:

```
>> m = [2 4 6; 3 6 9; 4 8 12]

m =

     2     4     6
     3     6     9
     4     8    12

>>
```

The 3x3 matrix is displayed as shown above in MATLAB.

Besides creating matrix with the values of your choice you can also make use of the built-in MATLAB functions zeros, rand or ones to create a matrix as shown below:

The zerosfunctions

This will create matrix with all zeros with the given row/column size.

You can use MATLAB zeros function as follows:

```
m0 = zeros(3,3);
```

You will get the following output:

```
>> m0 = zeros(3,3)

m0 =

     0     0     0
     0     0     0
     0     0     0

>>
```

The onesfunction

The matrix created will have ones as the values.

You can use MATLAB ones function as follows:

```
m1 = ones(3,3);
```

You will get the following output:

```
>> m1 = ones(3,3)

m1 =

     1     1     1
     1     1     1
     1     1     1

>>
```

The rand() function

The function rand() allows you to create a matrix with random elements for the size given.

Here is an example for the same:

```
m1 = rand(3,3)
```

Let us now execute the same in MATLAB to see the results. The output is as follows:

```
>> m1 = rand(3,3)

m1 =

    0.8147    0.9134    0.2785
    0.9058    0.6324    0.5469
    0.1270    0.0975    0.9575

>>
```

4. MATLAB MATRIX — Working with Matrices

In this chapter, I will deal with how to run the matrix inside MATLAB Environment to get the output. To define a matrix, and other matrix operations are discussed in details in the next chapters.

To get the matrix output in MATLAB will make use of:

- Command Prompt
- Using m-file

Using Command Prompt

You can execute matrices directly inside command prompt. Here is an example wherein we have two matrices *a* and *b*.

The operation *a+b* gives the sum of matrix *a* and *b*.

The operation *a-b* gives the subtraction of matrix *a* and *b*.

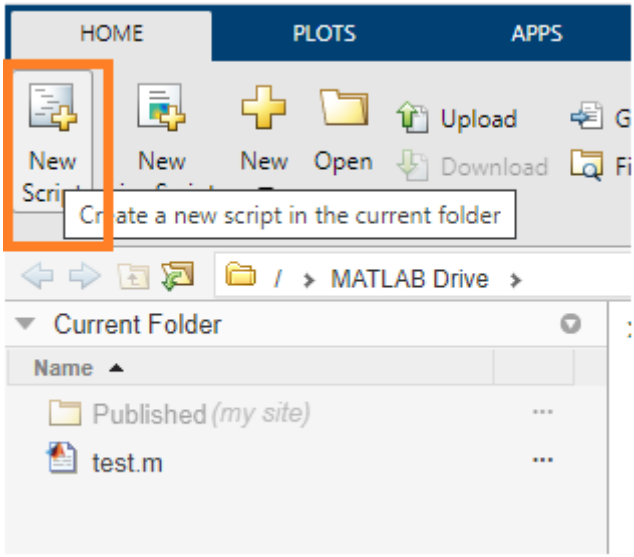
The output is command prompt is as shown below.

```
>> a = [ 1 2 3 ; 4 5 6; 7 8 9];
>> b = [ 7 5 6 ; 2 0 8; 5 7 1];
>> c = a + b

c =

     8     7     9
     6     5    14
    12    15    10

>> d = a - b

d =

    -6    -3    -3
     2     5    -2
     2     1     8

>>
```

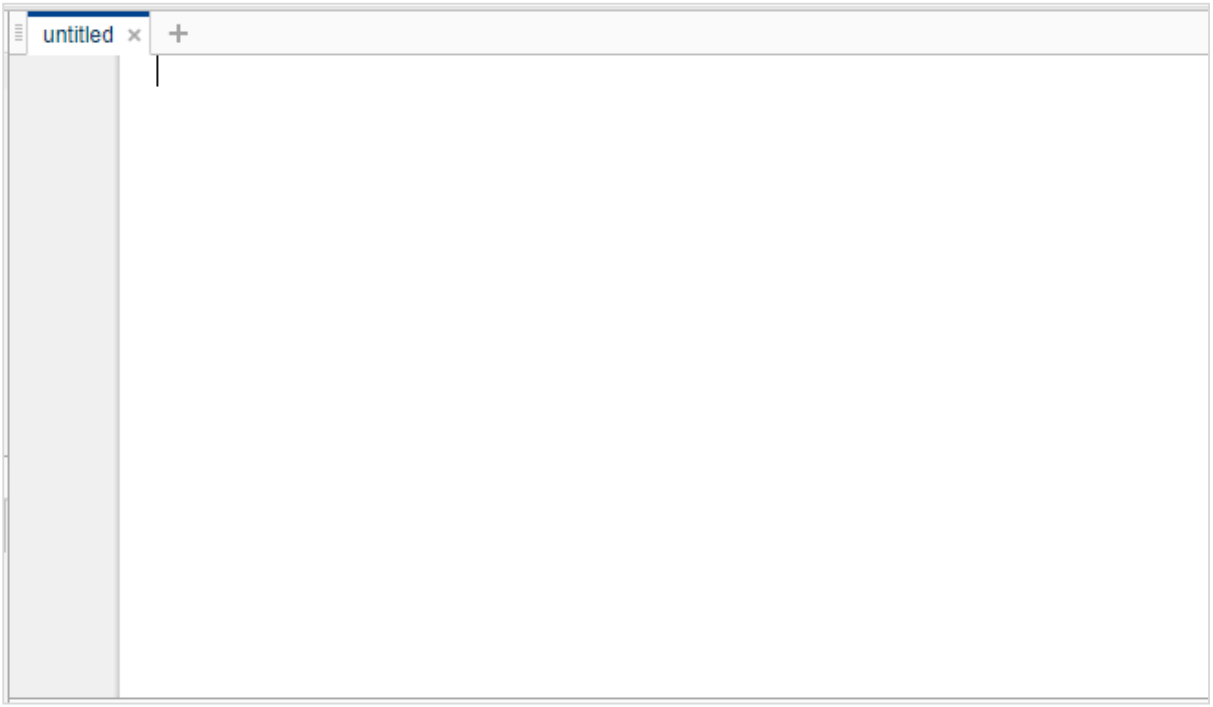
Using m-file

You can also make use of a file to write the code and later execute it inside command prompt as shown below:

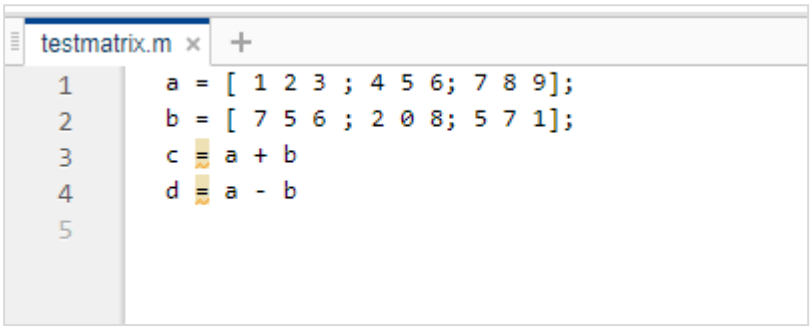
Click on New script as shown below:



This is open a new unsaved file as shown below:

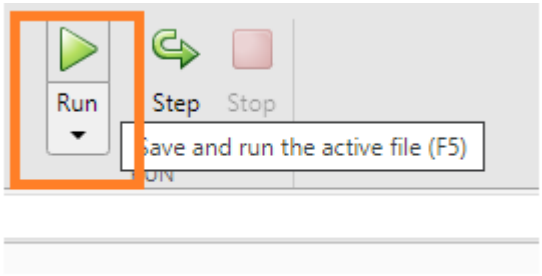


Save the file and write your code inside.



The file is saved as testmatrix.m.

Now you can use the run button or type the name of the file inside command window.



The output will be shown in the command window as shown below:

```
>> testmatrix

c =

     8     7     9
     6     5    14
    12    15    10


d =

    -6    -3    -3
     2     5    -2
     2     1     8

>>
```

5. MATLAB Matrix — Multiplication

Consider two matrices A and B. If A is an **m x n** matrix and B is an **n x p** matrix, they could be multiplied together to produce an m x n matrix C. Matrix multiplication is possible only if the number of columns n in A is equal to the number of rows n in B.

In matrix multiplication, the elements of the rows in the first matrix are multiplied with the corresponding columns in the second matrix.

Each element in the (i, j)thposition, in the resulting matrix C, is the summation of the products of elements in ith row of the first matrix with the corresponding element in the jth column of the second matrix.

Matrix multiplication in MATLAB is performed by using the * operator.

Example

Consider following example in MATLAB:

```
a = [ 1 2 3; 2 3 4; 1 2 5];
b = [ 2 1 3 ; 5 0 -2; 2 3 -1];
prod = a * b;
```

The execution in MATLAB will display the following result:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5];
b = [ 2 1 3 ; 5 0 -2; 2 3 -1];
prod = a * b


prod =

    18    10    -4
    27    14    -4
    22    16    -6

>>
```

The mtimes function

You can also make use of the function **mtimes** to multiply two given matrices. It is a built-in function available in MATLAB

Consider following example:

```
a = [ 1 2 3; 2 3 4; 1 2 5];
b = [ 2 1 3 ; 5 0 -2; 2 3 -1];
test= mtimes(a,b)
```

On execution in MATLAB the output is as follows:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5];
b = [ 2 1 3 ; 5 0 -2; 2 3 -1];
test= mtimes(a,b)


test =

    18    10    -4
    27    14    -4
    22    16    -6

>>
```

6. MATLAB Matrix — Addition

To add two matrices, both the operand matrices must have the same number of rows and columns.

Here is an example:

```
a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = a + b
```

On execution in MATLAB the result is as follows:

```
>> a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = a + b

c =

     8     7     9
     6     5    14
    12    15    10

>>
```

The plus() function

You can also make use of plus() built-in function to add two matrices as shown below:

Example

Consider the following example for the use of plus() function to add the two matrices:

```
a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = plus(a,b);
```

The execution in MATLAB is as shown below:

```
>> a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = plus(a,b)


c =

     8     7     9
     6     5    14
    12    15    10

>>
```

7. MATLAB Matrix — Subtraction

To subtract two matrices, both the operand matrices must have the same number of rows and columns.

Here is an example:

```
a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = a - b
```

On execution in MATLAB the result is as follows:

```
>> a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = a - b



c =

    -6    -3    -3
     2     5    -2
     2     1     8

>>
```

The minus() function

You can also make use of the minus() built-in function to subtract two matrices.

Consider the following example for use of minus() function for subtraction of two matrices:

```
a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
c = minus(a , b)
```

You will get the following result:

```
>> a = [ 1 2 3 ; 4 5 6; 7 8 9];
b = [ 7 5 6 ; 2 0 8; 5 7 1];
```

```
c = minus(a , b)



c =

    -6    -3    -3
     2     5    -2
     2     1     8

>>
```

8. MATLAB Matrix— Matrix Determinant

Determinant of a matrix is calculated by using the **det** function of MATLAB. For example, the determinant of a matrix A is given by det(A).

Consider following example for calculating the determinant of a matrix:

```
a = [ 1 2 3; 2 3 4; 1 2 5];
test = det(a)
```

The code on execution in MATLAB is as follows:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5];
test = det(a)


test =

    -2

>>
```

9. MATLAB Matrix — Inverse

The inverse of a matrix A is denoted by A−1 such that the following relationship holds:

```
AA−1 = A−1A = 1
```

The inverse of a matrix does not always exist. If the determinant of the matrix is zero, then the inverse does not exist and the matrix is singular.

Inverse of a matrix in MATLAB is calculated using the inv function. Inverse of a matrix A is given by inv(A).

Example

Here is an example to calculate inverse of given matrix:

```
a = [ 1 2 3; 2 3 4; 1 2 5];
test = inv(a)
```

The execution in MATLAB gives following result:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5];
test = inv(a)


test =

   -3.5000    2.0000    0.5000
    3.0000   -1.0000   -1.0000
   -0.5000         0    0.5000

>>
```

10. MATLAB Matrix — Trace

Trace helps you to calculate the sum of diagonal elements in a given matrix.

Consider the given 3x3 matrix. Let us find out the sum of diagonal elements as shown below:

```
a = [ 1 2 3; 2 3 4; 1 2 5];
test = trace(a)
```

The execution in MATLAB is as follows:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5]
test = trace(a)

a =

     1     2     3
     2     3     4
     1     2     5


test =

     9

>>
```

11. MATLAB Matrix — Rank

The rank of the matrix is the number of linearly independent columns in a matrix. The function rank() helps to return the rank of a given matrix.

Consider following example for the use of rank() function for a matrix:

```
a = [ 1 2 3; 2 3 4; 1 2 5]
test = rank(a)
```

The output in MATLAB on execution of the code is as follows:

```
>> a = [ 1 2 3; 2 3 4; 1 2 5]
test = rank(a)


a =

     1     2     3
     2     3     4
     1     2     5


test =

     3

>>
```

12. MATLAB Matrix — Transpose

The transpose operation switches the rows and columns in a matrix. It is represented by a single quote(').

Consider following example:

```
a = [ 10 12 23 ; 14 8 6; 27 8 9]
b = a'
```

The execution in MATLAB gives the following output:

```
>> a = [ 10 12 23 ; 14 8 6; 27 8 9]
b = a'


a =

    10    12    23
    14     8     6
    27     8     9


b =

    10    14    27
    12     8     8
    23     6     9

>>
```

The transpose() function

You can also make use of the transpose() function to get the transpose of a matrix.

Consider the following example for use of transpose() function:

```
a = [ 10 12 23 ; 14 8 6; 27 8 9]
b = transpose(a)
```

You will get the following output:

```
>> a = [ 10 12 23 ; 14 8 6; 27 8 9]
b = transpose(a)


a =

    10    12    23
    14     8     6
    27     8     9


b =

    10    14    27
    12     8     8
    23     6     9

>>
```

13. MATLAB Matrix — Deletion of Row and Column

You can delete an entire row or column of a matrix by assigning an empty set of square braces [] to that row or column. Basically, [] denotes an empty array.

For example, let us delete the fourth row of a, as shown below:

```
a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8];
a( 4 , : ) = []
```

Here is the execution of above code in MATLAB:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]
a( 4 , : ) = []


a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8


a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7

>>
```

The fourth row is deleted. It displays only three rows.

Next, let us delete the fifth column of a, as shown below:

```
a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]
a(: , 5)=[]
```

Let us see the execution of the above code in MATLAB:

```
>> a = [ 1 2 3 4 5; 2 3 4 5 6; 3 4 5 6 7; 4 5 6 7 8]
a(: , 5)=[]


a =

     1     2     3     4     5
     2     3     4     5     6
     3     4     5     6     7
     4     5     6     7     8


a =

     1     2     3     4
     2     3     4     5
     3     4     5     6
     4     5     6     7

>>
```