

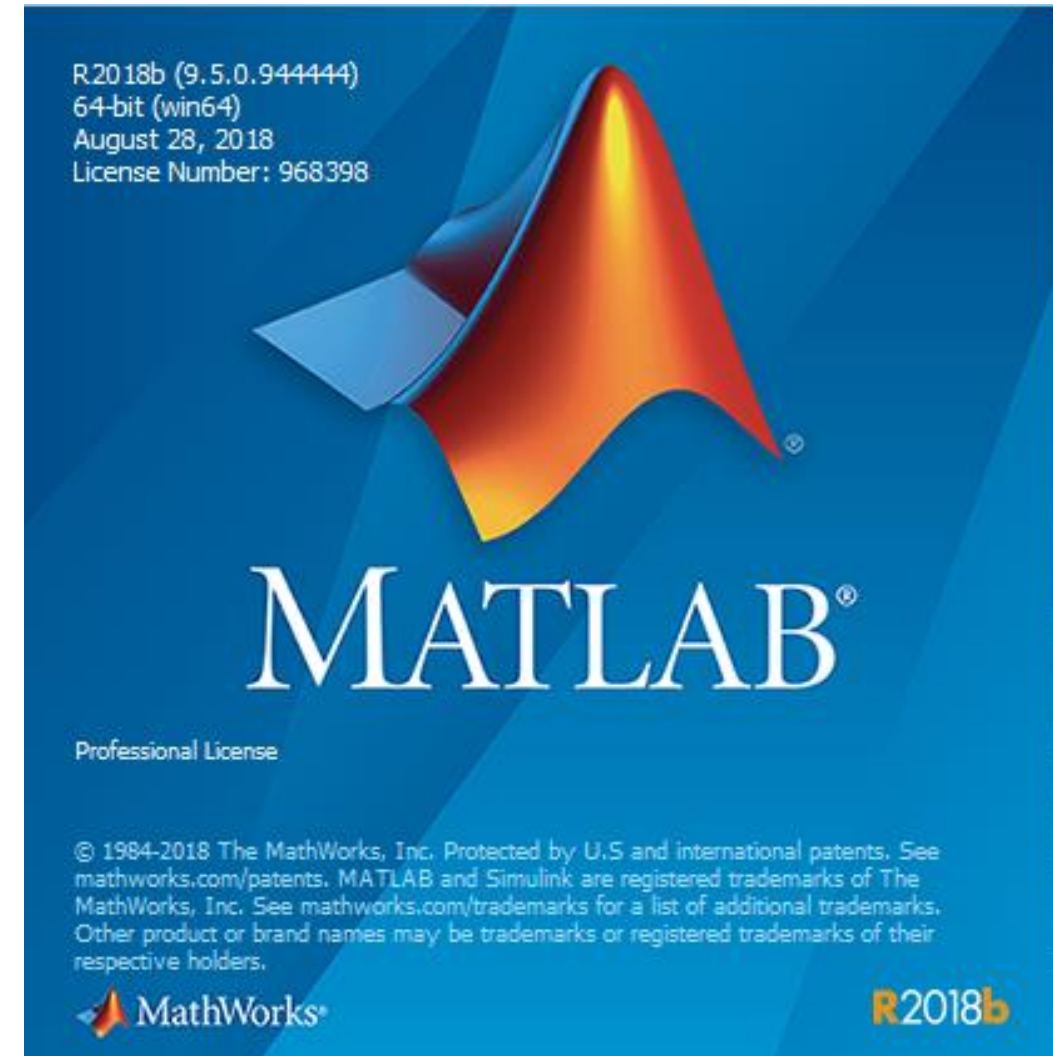
Linear Algebra with MATLAB

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What is MATLAB?

- **MATLAB** stands for Matrix Laboratory.
- It is forth generation **technical computing** and **programming language**.
- All the computations performed and programs implemented in MATLAB environment are **based on matrix**.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \dots & a_{3n} \\ \dots & \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & a_{n3} & \dots & a_{nn} \end{bmatrix}$$



Arithmetic

$+, -, \times, \div, x^2$

Calculus

$\int, d/dx$

Trigonometric

$\sin(x), \cos(x),$
 $\tan(x)$

$$\begin{aligned} 2x + 5y - 3 &= 0 \\ 3x - 4y + 6 &= 0 \end{aligned}$$

2 unknowns,
2 equations

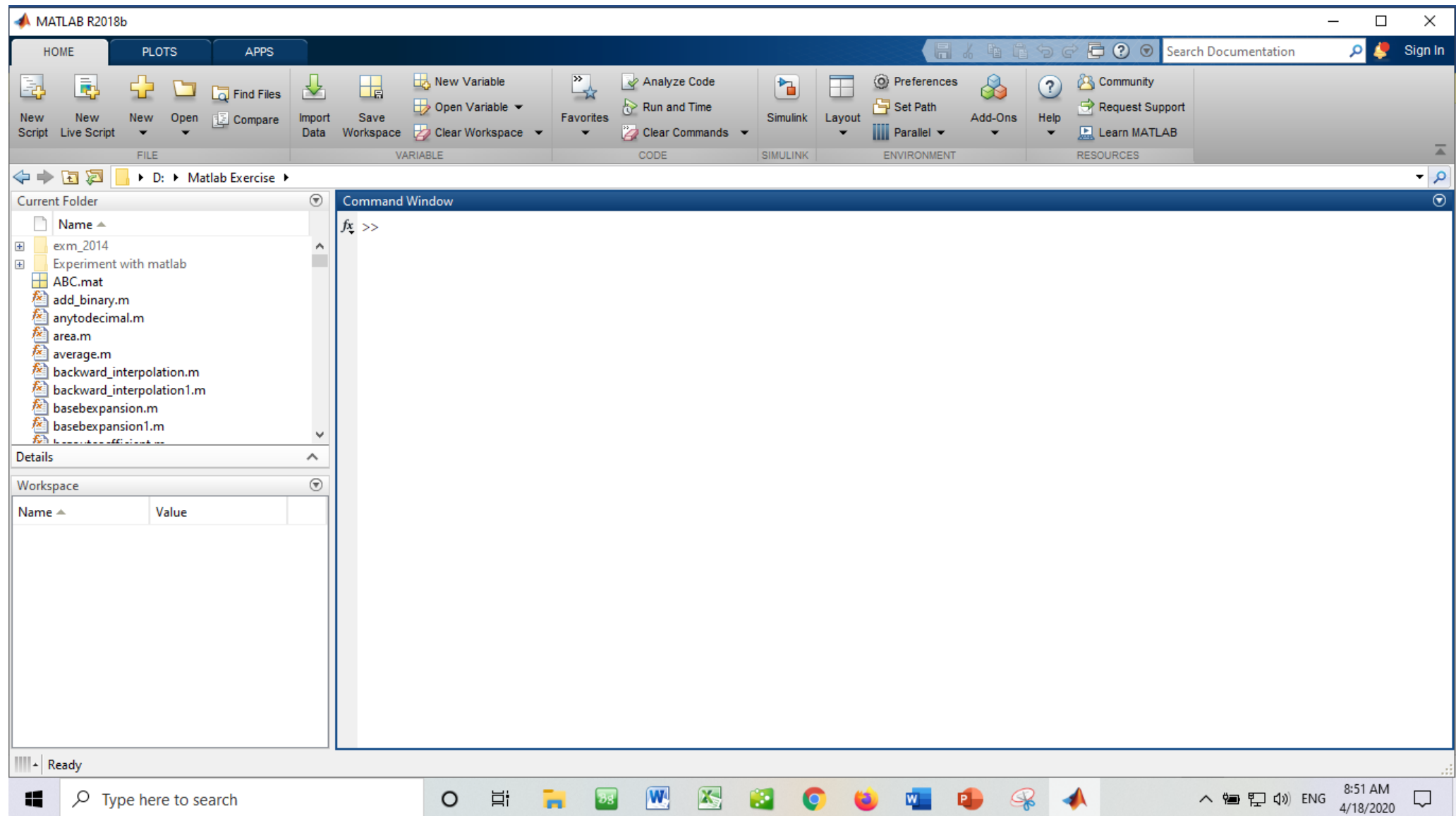


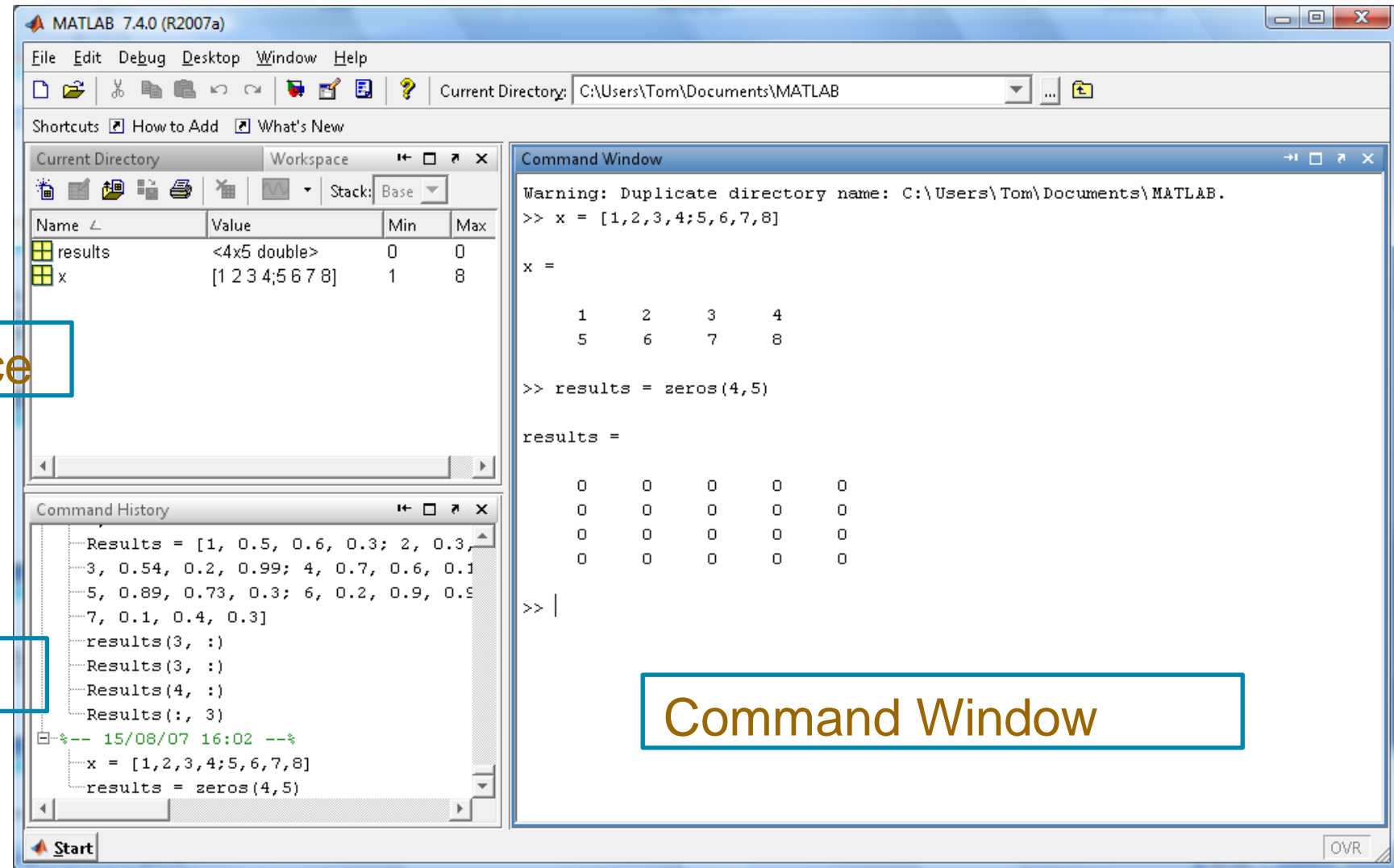
100 unknowns,
100 equations



Linear Algebra with MATLAB

The MATLAB Desktop (Window)





Workspace

Command History

Command Window

Linear Algebra with MATLAB

MATLAB Online

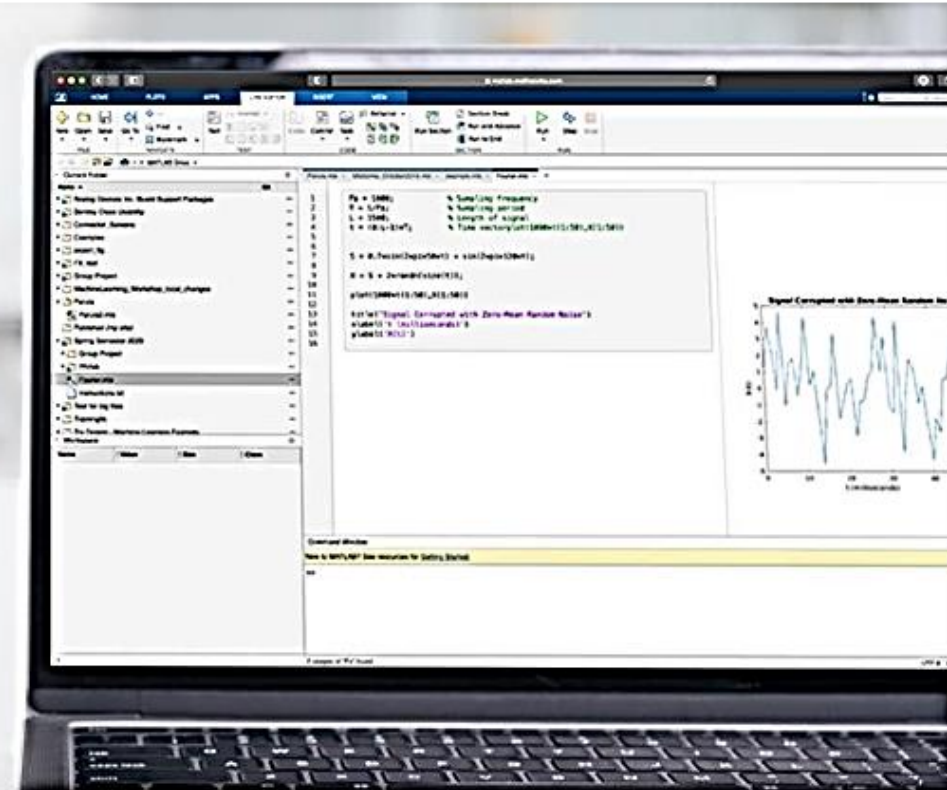
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MATLAB Online

[Overview](#)[Specifications and Limitations](#)[System Requirements](#)[Accessing Data](#)[MATLAB Online Versions](#)[Linking to GitHub](#)

MATLAB Online

Use MATLAB and Simulink through your web browser

[Start using MATLAB Online](#)

Linear Algebra with MATLAB

MATLAB Online

The image shows the MATLAB Online web interface. At the top is a green header with the title 'Linear Algebra with MATLAB' and 'MATLAB Online'. Below the header is a dark blue navigation bar with tabs for 'HOME', 'PLOTS', and 'APPS'. A search bar is located on the right side of the navigation bar. Below the navigation bar is a light gray toolbar with various icons and labels for file operations (New Script, Live Script, Open, Find Files), variable operations (Import Data, Save Workspace, New Variable, Open Variable, Clear Workspace), code operations (Favorites, Clear Commands), Simulink, Layout, Set Path, Add-Ons, Preferences, Help, Community, Feedback, and Learn MATLAB. Below the toolbar is a breadcrumb navigation bar showing the current location as 'MATLAB Drive'. On the left side, there is a 'Files' panel showing a list of files: 'marlar.m', 'marlar.mlx', and 'test.m'. Below the 'Files' panel is a 'Workspace' panel with columns for 'Name' and 'Value'. The main area of the interface is the 'Command Window', which is currently empty and shows the prompt '>>'. At the bottom of the interface is a status bar with the text 'Ready'.

HOME PLOTS APPS Search (Ctrl+Shift+Space) Marlar

New Script New Live Script New Open Go to File Find Files Import Data Save Workspace New Variable Open Variable Clear Workspace Favorites Clear Commands Simulink Layout Set Path Add-Ons Preferences Help Community Feedback Learn MATLAB

FILE VARIABLE CODE SIMULINK ENVIRONMENT RESOURCES

MATLAB Drive

Files

- marlar.m
- marlar.mlx
- test.m

Workspace


Name	Value
------	-------

Command Window

>>


Ready

Eg, `>>clc`
`>>clear`
`>>exit`



Commands

Eg, `>>date`
`>>sqrt(144)`
`>>calendar`



Functions


```
>> date
```

```
ans =
```

```
    '05-Jun-2023'
```

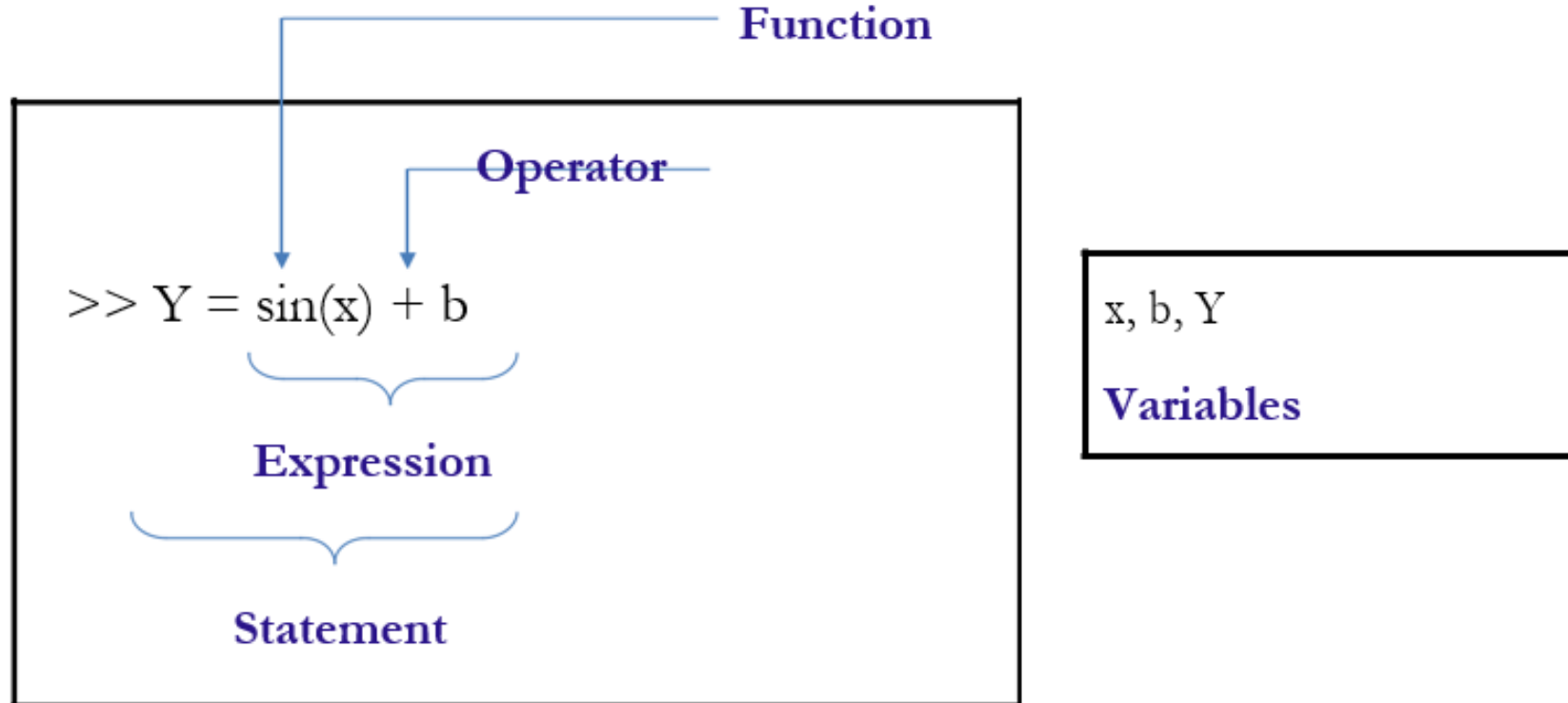
```
>> sqrt(169)
```

```
ans =
```

```
    13
```

```
>> calendar
```

```
           Jun 2023
  S      M      Tu      W      Th      F      S
   0       0       0       0       1       2       3
   4       5       6       7       8       9      10
  11      12      13      14      15      16      17
  18      19      20      21      22      23      24
  25      26      27      28      29      30       0
   0       0       0       0       0       0       0
```



`>> 2*sin(x)` (**Expression**)

`>> Y = sin(2*x)` (**Statement**)

Matrices are stored as two-dimensional arrays in **MATLAB**. A matrix is a collection of numbers and/or scalars arranged in rows and columns.

```
>> v=[4;2]
```

```
v =
```

```
4
```

```
2
```

```
>> 2*v
```

```
ans =
```

```
8
```

```
4
```

```
>> v+w
```

```
ans =
```

```
3
```

```
4
```

```
>> w=[-1;2]
```

```
w =
```

```
-1
```

```
2
```

```
>> -1*w
```

```
ans =
```

```
1
```

```
-2
```

```
>> v-w
```

```
ans =
```

```
5
```

```
0
```

Matrices are entered into MATLAB row by row with rows separated either by semicolons or by line returns. To enter the 2×3 matrix ,

$$A = \begin{bmatrix} 2 & 3 & 1 \\ 1 & 4 & 7 \end{bmatrix}$$

just type

```
>> A=[2 3 1;1 4 7]
```

```
A =
```

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

MATLAB has very sophisticated methods for addressing the entries of a matrix. You can directly address individual entries, individual rows, and individual columns. To display the entry in the 1st row, 3rd column of A, type `A(1,3)`. To display the 2nd column of A, type `A(:,2)`; and to display the 1st row of A, type `A(1,:)`. For example, to add the two rows of A and store them in the vector x, just type

```
>> x = A(1,:) + A(2,:)
```

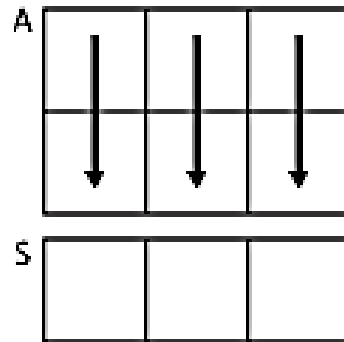
```
x =
```

```
3
```

```
7
```

```
8
```

- `sum(A,1)` operates on successive elements in the columns of A and returns a row vector of the sums of each column.



`sum(A,1)`

```
>> A=[2 3 1;1 4 7]
```

$A =$

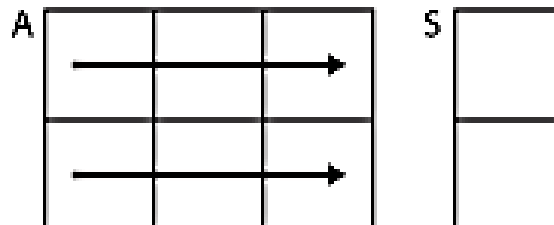
2	3	1
1	4	7

```
>> sum(A,1)
```

$ans =$

3	7	8
---	---	---

- `sum(A,2)` operates on successive elements in the rows of A and returns a column vector of the sums of each row.



`sum(A,2)`

```
>> sum(A,2)
```

$ans =$

6
12

1. Enter the 3×4 matrix

$$A = \begin{pmatrix} 1 & 2 & 5 & 7 \\ -1 & 2 & 1 & -2 \\ 4 & 6 & 8 & 0 \end{pmatrix}.$$

As usual, let a_{ij} denote the entry of A in the i^{th} row and j^{th} column. Use MATLAB to compute the following:

- (a) $a_{13} + a_{32}$.
- (b) Three times the 3^{rd} column of A .
- (c) Twice the 2^{nd} row of A minus the 3^{rd} row.
- (d) The sum of all of the columns of A .

```
>> A=[1 2 5 7;-1 2 1 -2;4 6 8 0]
```

A =

```

     1     2     5     7
    -1     2     1    -2
     4     6     8     0
```

(b) Three times the 3rd column of A.

```
>> 3*A(:,3)
```

ans =

```

    15
     3
    24
```

(a) $a_{13} + a_{32}$.

```
>> A(1,3)+A(3,2)
```

ans =

```

    11
```

(c) Twice the 2nd row of A minus the 3rd row.

```
>> 2*A(2,:)-A(3,:)
```

ans =

```

    -6    -2    -6    -4
```

(d) The sum of all of the columns of A.

```
>> sum(A,2)
```

ans =

```

    15
     0
    18
```

- **A square matrix** is a matrix with the same number of rows and columns; that is, a square matrix is an $n \times n$ matrix.
- **A diagonal matrix** is a square matrix whose only nonzero entries are along the main diagonal; that is, $a_{ij} = 0$ if $i \neq j$. The following is a 3×3 diagonal matrix.

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

```
>> diag([1 2 3])
```

```
ans =
```

```
1     0     0
0     2     0
0     0     3
```

- **The identity matrix** is the diagonal matrix all of whose diagonal entries equal 1.

The $n \times n$ identity matrix is denoted by I_n .

```
>> eye(3)
```

```
ans =
```

```
    1    0    0
    0    1    0
    0    0    1
```

- **A zero matrix** is a matrix all of whose entries are 0. A zero matrix is denoted by 0 .

```
>> A=zeros(3,4)
```

```
A =
```

0	0	0	0
0	0	0	0
0	0	0	0

- The transpose of an $m \times n$ matrix A is the $n \times m$ matrix obtained from A by interchanging rows and columns.

```
>> A=[2 1;-1 2;3 4;5 7]
```

```
A =
```

```
     2     1
    -1     2
     3     4
     5     7
```

```
>> A'
```

```
ans =
```

```
     2    -1     3     5
     1     2     4     7
```


$$\cos \theta = \frac{x \cdot y}{\|x\| \|y\|}$$

```
>> x = [1 ;4 ;2]; y = [2 ;3 ;-1]; dot(x,y)
```

```
ans =
```

```
12
```

```
>> norm(x)
```

```
ans =
```

```
4.5826
```

```
>> norm(y)
```

```
ans =
```

```
3.7417
```

```
>> theta=acos(dot(x,y)/(norm(x)*norm(y)))
```

```
theta =
```

```
0.7956
```

```
>> rad2deg(theta)
```

```
ans =
```

```
45.5847
```

Find the angle in degrees between the given pair of vectors.

$$1. \quad u = \begin{bmatrix} 2 \\ 1 \\ -3 \\ 4 \end{bmatrix}, v = \begin{bmatrix} 1 \\ 1 \\ -5 \\ 7 \end{bmatrix}$$

$$2. \quad x = \begin{bmatrix} 2.43 \\ 10.2 \\ -5.27 \\ \pi \end{bmatrix}, y = \begin{bmatrix} -2.2 \\ 0.33 \\ 4 \\ -1.7 \end{bmatrix}$$

```
>> u=[2;1;-3;4]
```

```
u =
```

```
    2  
    1  
   -3  
    4
```

```
>> v=[1;1;-5;7]
```

```
v =
```

```
    1  
    1  
   -5  
    7
```

```
>> dot(u,v)
```

```
ans =
```

```
46
```

```
>> cosinetheta=dot(u,v)/(norm(u)*norm(v))
```

```
cosinetheta =
```

```
0.9634
```

```
>> theta=acos(cosinetheta)
```

```
theta =
```

```
0.2715
```

```
>> rad2deg(theta)
```

```
ans =
```

```
15.5570
```

```
>> x=[2.43;10.2;-5.27;pi]
```

```
x =
```

```
    2.4300  
   10.2000  
   -5.2700  
    3.1416
```

```
>> y=[-2.2;0.33;4;-1.7]
```

```
y =
```

```
   -2.2000  
    0.3300  
    4.0000
```

```
>> dot(x,y)
```

```
ans =
```

```
-28.4007
```

```
>> cosinetheta=dot(x,y)/(norm(x)*norm(y))
```

```
cosinetheta =
```

```
   -0.4788
```

```
>> theta=acos(cosinetheta)
```

```
theta =
```

```
    2.0701
```

```
>> rad2deg(theta)
```

```
ans =
```

```
   118.6076
```

Thanks for your attention.

