Vectors and its Applications

Lecture: 6 (Dr. Ajeet Kumar)

How to create vectors??

Method 1:

Syntax: v=1:1:10;

```
v=1:2:10
```

```
v = 1×5
     1     3     5     7     9
```

```
v=1:3:10
```

```
v = 1×4
     1     4     7    10
```

Method 2:

Syntax: v=linspace(1,10,10)

```
v=linspace(1,10,10)
```

```
v = 1×10
     1     2     3     4     5     6     7     8     9    10
```

```
v=linspace(1,10,5)
```

```
v = 1×5
            1         3.25          5.5         7.75           10
```

Problem: 1

Write a program to print square of the numbers between 1 to 20 and also calculate the summation of these numbers.

Solution

Step 1

create the numbers between 1 to 20 (n is a row vector)

```
n=1:20
```

```
n = 1×20
     1     2     3     4     5     6     7     8     9    10    11    12    13 ···
```

Step 2

calculate the square of the numbers

```
N_square=n.^2
```

```
N_square = 1×20
     1     4     9    16    25    36    49    64    81   100   121   144   169 ···
```

Step 3

Summation of the squares of these numbers

```
N_sum=sum(N_square)
```

```
N_sum =
        2870
```

Combined Code

```
% Solution of Problem 1
% Calculation of squares of the all the no. between 1 and 20 and their
% summation

n=1:20;
N_square=n.^2
```

```
N_square = 1×20
     1     4     9    16    25    36    49    64    81   100   121   144   169 ···
```

```
N_sum=sum(N_square)
```

```
N_sum =
        2870
```

```

```

Problem: 2

Write a program to print square of all the odd numbers between 1 to 20 and also calculate the summation of these numbers.

Solotion

Step 1

create all the odd numbers between 1 to 20 (n is a row vector)

```
n=1:2:20
```

```
n = 1×10
```

```
     1     3     5     7     9    11    13    15    17    19
```

Step 2

calculate the square of the numbers

```
N_square=n.^2
```

```
N_square = 1×10
     1     9    25    49    81   121   169   225   289   361
```

Step 3

Summation of the squares of these numbers

```
N_sum=sum(N_square)
```

```
N_sum = 1330
```

Combined Code

```
% Solution of Problem 2
% Calculation of squares of the all the odd no. between 1 and 20 and their
% summation
n=1:2:20;
N_square=n.^2
N_sum=sum(N_square)
```

Problem: 3

Write a program to print cube of all the even numbers between 1 to 20. Print all even numbers in one column and their cube values in the next column. Also calculate the summation of cube of these numbers.

Solution

Step 1

create all the even numbers between 1 to 20 (n is a row vector)

```
% n=2:2:20
n=2:2:20
```

```
n = 1×10
     2     4     6     8    10    12    14    16    18    20
```

Step 2

calculate the square of these numbers

```
% N_cube=n.^3
N_cube=n.^3
```

```
N_cube = 1×10
     8    64   216   512  1000  1728 ···
```

Step 3

Arranging the even numbers and their respective squares column-wise and formring a Matrix for better presentation of output.

n' = column vector, N_cube' =column vector having same numbers of rows (Adding column)

```
% table_cube=[n' N_cube']
% cube_summation=sum(N_cube)
table_cube=[n' N_cube']
```

```
table_cube = 10×2
     2     8
     4    64
     6   216
     8   512
    10  1000
    12  1728
    14  2744
    16  4096
    18  5832
    20  8000
```

```
cube_summation=sum(N_cube)
```

```
cube_summation = 24200
```

Combined Code

```
% Solution of Problem 3
%  Write a program to print cube of all the even numbers between 1 to 20.
%  Print all even numbers in one column and their square values in the next column.
% Also calculate the summation of squares of these numbers.

% n=2:2:20;
% N_cube=n.^3;
% table_cube=[n' N_cube']
% cube_summation=sum(N_cube)
```

Problem: 4

The (n+1)th term in the Fibonacci series is given as

$$T_{n+1} = \frac{\left[\left(\frac{(1+\sqrt{5})}{2}\right)^n - \left(\frac{(1-\sqrt{5})}{2}\right)^n\right]}{\sqrt{5}}$$; n =0,1,2,3,.....

Display the first 10 terms of the series and find out the summation.

Solution

Step 1

create n from 0 to 9 in order to generate 10 terms of the series

```
% n=0:9
n=0:9
```

```
n = 1×10
     0     1     2     3     4     5     6     7     8     9
```

Step 2

Define the term: Hint: split the bigger term into smaller term

T_n+1=(Tn_1-Tn_2)/sqrt(5) where Tn_1 and Tn_2 are the terms of the numerator

```
% Tn_1=((1+sqrt(5))/2).^n;
% Tn_2=((1-sqrt(5))/2).^n;
% T_n= (Tn_1-Tn_2)/sqrt(5)
Tn_1=((1+sqrt(5))/2).^n;
Tn_2=((1-sqrt(5))/2).^n;
T_n=(Tn_1-Tn_2)/sqrt(5)
```

```
T_n = 1×10
         0    1.0000    1.0000    2.0000    3.0000    5.0000    8.0000   13.0000 ···
```

Step 3

Summation of the terms

```
% Fib_sum=sum(T_n)
Fib_sum=sum(T_n)
```

```
Fib_sum = 88
```

Combined Code

```
% Problem 4
% Fibonacci series
% n=0:9;
% Tn_1=((1+sqrt(5))/2).^n;
% Tn_2=((1-sqrt(5))/2).^n;
% T_n= (Tn_1-Tn_2)/sqrt(5)
% Fib_sum=sum(T_n)
```

Problem 5:

Write a program to plot the sine curve between 0 to 2*pi.

Step 1:

Create a vector of theta between 0 to 2*pi

```
% th=linspace(0,2*pi,1000);
th=linspace(0,2*pi,100);
```

Step 2:

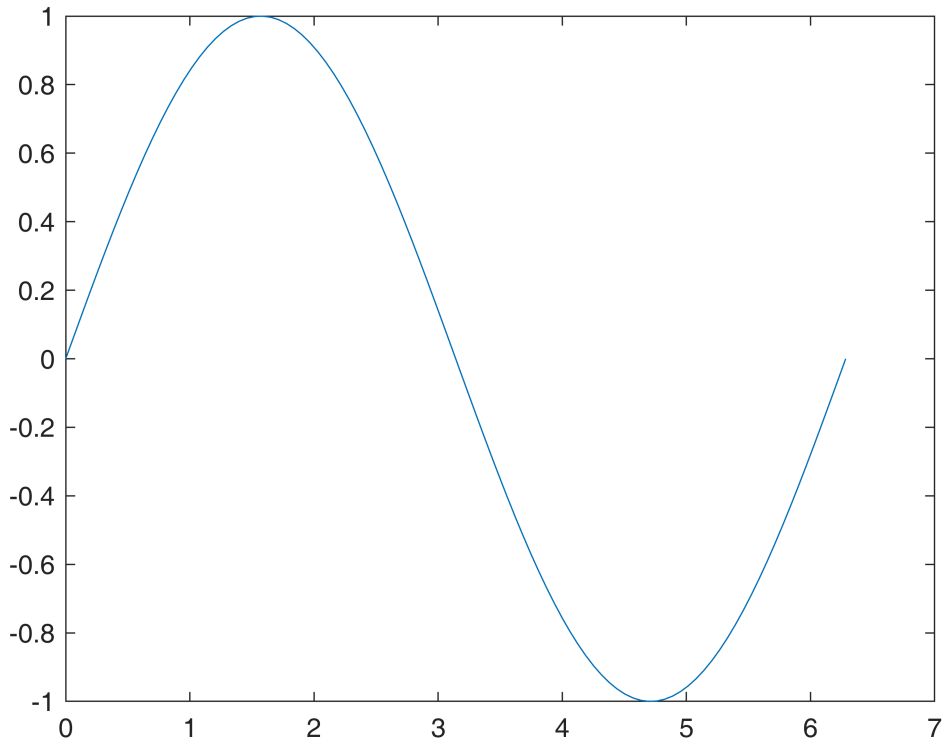
Calculate the sine value corresponding to these theta value and store them

```
% sin_th=sin(th);
sin_th=sin(th);
```

Step 3:

Use Matlab Plot option to show the variation of sine

```
% plot(th,sin_th);
plot(th,sin_th)
```



Problem 6:

The maximum height h achieved by an object thrown with a speed v at an angle θ to the horizontal, neglecting drag, is

$$h = \frac{v^2 \sin^2\theta}{2g}$$

Create a table showing the maximum height for the following values of v and θ:

$v = 10, 12, 14, 16, 18, 20$ m/s $\qquad$ $\theta = 50°, 60°, 70°, 80°$

The rows in the table should correspond to the speed values, and the columns should correspond to the angles.

Output should be like this table

0	50	60	70	
10				
12				
14				
16				
18				
20				

Note: This is an example where one should be careful because the solution requires array and matrix operation all together.

From above table, it is clear that in order to fill the blank entries, we need an generate output "h" of 6X4 matrix.

6X4 matrix output can be get by performing matrix multiplication of velocity vector (v^2) of 6x1 and angle vector ($\sin^2\theta$) of 1x4.

Once this matrix "h" has been created, one can add entries corresponding to 1st row (angle input) and 1st column (velocity input) as shown in above figure.

Thus one can conclude that above calculation needs both array and matrix operation (That why one should very careful while using OPERATORS SIGN)

Step 1.

Defining constant and vectors as an input

```
clear all
format short g
% g=9.8                    % constant
% v=10:2:20                % velocity   row vector, dim: 1x6
% th=50:10:80              % angle      row vector, dim: 1x6
g=9.8;
v=10:2:20;
th=50:10:80;
```

Step 2:

Defining formula for h to calculate the matrix h of size 6x4

$$\begin{bmatrix} v_1^2 \\ v_2^2 \\ v_3^2 \\ v_4^2 \\ v_5^2 \\ v_6^2 \end{bmatrix}_{6\times1} \times \begin{bmatrix} \sin^2\theta_1 & \sin^2\theta_2 & \sin^2\theta_3 & \sin^2\theta_4 \end{bmatrix}_{1\times4} = \begin{bmatrix} v_1^2\sin^2\theta_1 & v_1^2\sin^2\theta_2 & v_1^2\sin^2\theta_3 & v_1^2\sin^2\theta_4 \\ v_2^2\sin^2\theta_1 & v_2^2\sin^2\theta_2 & v_2^2\sin^2\theta_3 & v_2^2\sin^2\theta_4 \\ v_3^2\sin^2\theta_1 & v_3^2\sin^2\theta_2 & v_3^2\sin^2\theta_3 & v_3^2\sin^2\theta_4 \\ v_4^2\sin^2\theta_1 & v_4^2\sin^2\theta_2 & v_4^2\sin^2\theta_3 & v_4^2\sin^2\theta_4 \\ v_5^2\sin^2\theta_1 & v_5^2\sin^2\theta_2 & v_5^2\sin^2\theta_3 & v_5^2\sin^2\theta_4 \\ v_6^2\sin^2\theta_1 & v_6^2\sin^2\theta_2 & v_6^2\sin^2\theta_3 & v_6^2\sin^2\theta_4 \end{bmatrix}_{6\times4}$$

Thus we need to convert velocity vector as column vector of 6x1

```
% h=((v'.^2)*(sind(th).^2))./2*g
h=((v'.^2)*(sind(th).^2))./2*g
```

```
h = 6×4
       287.54        367.5       432.68       475.22
       414.06        529.2       623.06       684.32
       563.59        720.3       848.05       931.44
       736.11        940.8       1107.7       1216.6
       931.64       1190.7       1401.9       1539.7
       1150.2         1470       1730.7       1900.9
```

Step 3:

Creating table

```
% tabulated_output_1=[0 th; v' h]
% tabulated_output_2=[[0; v'] [th; h]]
tabulated_output_1=[0 th;v' h]
```

```
tabulated_output_1 = 7×5
           0          50          60          70          80
          10      287.54       367.5      432.68      475.22
          12      414.06       529.2      623.06      684.32
```

```
    14       563.59        720.3       848.05       931.44
    16       736.11        940.8       1107.7       1216.6
    18       931.64       1190.7       1401.9       1539.7
    20       1150.2         1470       1730.7       1900.9
```

```
tabulated_output_2=[[0;v'] [th;h] ]
```

```
tabulated_output_2 = 7×5
     0          50          60          70          80
    10       287.54       367.5       432.68       475.22
    12       414.06       529.2       623.06       684.32
    14       563.59       720.3       848.05       931.44
    16       736.11       940.8       1107.7       1216.6
    18       931.64      1190.7       1401.9       1539.7
    20       1150.2        1470       1730.7       1900.9
```

Problem 7:

The mechanical work W done in using a force F to
distance D is $W = FD$. The following table gives d
force used to push a block through the given distan
of a certain path. The force varies because of the di
ties of the surface.

	Path segment			
	1	2	3	4
Force (N)	400	550	700	500
Distance (m)	2	0.5	0.75	1.5

Use MATLAB to find (*a*) the work done on each s
(*b*) the total work done over the entire path.

Also find out the path along with minimum work has been done.