DATA SCIENCE & MACHINE LEARNING

<u>LAB CYCLE 2</u>

1. **Create a three dimensional array specifying float data type and print it.**

```
import numpy as np
a=np.array([[[1,2],[3,4]],[[5,6],[7,8]]],dtype=float)
print(a)
```

```
In [15]: runfile('/home/sjcet/23Dona_DSML/
[[[1. 2.]
  [3. 4.]]

 [[5. 6.]
  [7. 8.]]]
```

2. **Create a 2 dimensional array (2X3) with elements belonging to complex data type and print it. Also display**
   a. **the no: of rows and columns**
   b. **dimension of an array**
   c. **reshape the same array to 3X2**

```
import numpy as np
a=np.array([[1,2,3],[4,5,6]],dtype=complex)
print("2x3 Array :")
print(a)
print("Rows and Columns : ",a.shape)
print("Dimension : ",a.ndim)
print("Reshape to 3x2 Array : ")
newArr=a.reshape(3,2)
print(newArr)
print("Rows and Columns : ",newArr.shape)
```

```
In [16]: runfile('/home/sjcet/23Dona_DSML/untitled4.py', wdir='/home/sjcet/23Dona_DSML')
2x3 Array :
[[1.+0.j 2.+0.j 3.+0.j]
 [4.+0.j 5.+0.j 6.+0.j]]
Rows and Columns :  (2, 3)
Dimension :  2
Reshape to 3x2 Array :
[[1.+0.j 2.+0.j]
 [3.+0.j 4.+0.j]
 [5.+0.j 6.+0.j]]
Rows and Columns :  (3, 2)
```

3. **Familiarize with the functions to create**
   a) **an uninitialized array**
   b) **array with all elements as 1**
   c) **all elements as 0**

```
import numpy as np
print("Uninitialized Array")
a = np.full([2, 3], None)
print(a)

b = np.ones(3,dtype=int)
print("Array with all elements 1 : ",b)

c = np.zeros(3,dtype=int)
print("Array with all elements 0 : ",c)
```

```
Cycle 2')
Uninitialized Array
[[None None None]
 [None None None]]
Array with all elements 1 :  [1 1 1]
Array with all elements 0 :  [0 0 0]

In [10]:
```

4. **Create an one dimensional array using arange function containing 10 elements. Display**
    a. **First 4 elements**
    b. **Last 6 elements**
    c. **Elements from index 2 to 7**

```
import numpy as np
a = np.arange(1, 11, 1)
print(a)
element1 = a[:4]
print("First 4 elements : ",element1)
element2 = a[4:]
print("Last 6 elements : ",element2)
element3 = a[2:8]
print("index 2 to 7 : ",element3)
```

```
[ 1  2  3  4  5  6  7  8  9 10]
First 4 elements :  [1 2 3 4]
Last 6 elements :  [ 5  6  7  8  9 10]
index 2 to 7 :  [3 4 5 6 7 8]

In [16]:
```

5. **Create an 1D array with arange containing first 15 even numbers as elements**
    a. **Elements from index 2 to 8 with step 2(also demonstrate the same using slice function)**
    b. **Last 3 elements of the array using negative index**
    c. **Alternate elements of the array**
    d. **Display the last 3 alternate elements**

```
import numpy as np
n = int(input("How many elements you want? : "))
n = 2*n
a=np.arange(0,n,2)
print("Even Array : ",a)

print("Elements from index 2 to 8 : ",a[2:9])
x = slice(2,9)
print("Elements from 2 to 8 using slice() : ",a[x])

print("Last 3 Elements:",a[-3:])

b = a[::2]
print("Alternate elements : ",b)

print("Last 3 Alternate Numbers:",b[-3:])
```

```
How many elements you want? : 15
Even Array :  [ 0  2  4  6  8 10 12 14 16 18 20 22 24 26 28]
Elements from index 2 to 8 :  [ 4  6  8 10 12 14 16]
Elements from 2 to 8 using slice() :  [ 4  6  8 10 12 14 16]
Last 3 Elements: [24 26 28]
Alternate elements :  [ 0  4  8 12 16 20 24 28]
Last 3 Alternate Numbers: [20 24 28]
```

6. **Create a 2 Dimensional array with 4 rows and 4 columns.**
    a. **Display all elements excluding the first row**
    b. **Display all elements excluding the last column**
    c. **Display the elements of 1^{st} and 2^{nd} column in 2^{nd} and 3^{rd} row**
    d. **Display the elements of 2^{nd} and 3^{rd} column**
    e. **Display 2^{nd} and 3^{rd} element of 1^{st} row**
    f. **Display the elements from indices 4 to 10 in descending order(use – values)**

```
import numpy as np

x = np.array([[2, 4, 6,1], [6, 8, 10,1],[1, 2, 1,1], [1, 1, 1,1]])
print("4x4 2D Array :")
print(x)

print("Display all elements excluding the first row")
print(x[1:])

print("Display all elements excluding the last column")
print(x[:, :3])

print("Display the elements of 1st & 2nd column in 2nd & 3rd row")
print(x[1:3, 0:2])

print("Display the elements of 2 nd and 3 rd column")
print(x[:, 1:3])

print("Display 2 nd and 3 rd element of 1 st row")
print(x[0,1])
print(x[0,2])

print("Display the elements from indices 4 to 10 in descending order(use-
values)")
a = np.array([1,2,8,9,3,4,5,6,7])
print("Array : ",a)
array_copy = np.sort(a)[::-1]
print("Sorted Array :",array_copy)
print("Index 4 to 10 : " ,array_copy[4:10])
```

```
4x4 2D Array :
[[ 2  4  6  1]
 [ 6  8 10  1]
 [ 1  2  1  1]
 [ 1  1  1  1]]
Display all elements excluding the first row
[[ 6  8 10  1]
 [ 1  2  1  1]
 [ 1  1  1  1]]
Display all elements excluding the last column
[[ 2  4  6]
 [ 6  8 10]
 [ 1  2  1]
 [ 1  1  1]]
Display the elements of 1st & 2nd column in 2nd & 3rd row
[[6 8]
 [1 2]]
Display the elements of 2 nd and 3 rd column
[[ 4  6]
 [ 8 10]
 [ 2  1]
 [ 1  1]]
Display 2 nd and 3 rd element of 1 st row
4
6
Display the elements from indices 4 to 10 in descending order(use -values)
Array :  [1 2 8 9 3 4 5 6 7]
Sorted Array : [9 8 7 6 5 4 3 2 1]
Index 4 to 10 :  [5 4 3 2 1]
```

7. **Create two 2D arrays using array object and**
   a. **Add the 2 matrices and print it**
   b. **Subtract 2 matrices**
   c. **Multiply the individual elements of matrix**
   d. **Divide the elements of the matrices**
   e. **Perform matrix multiplication**
   f. **Display transpose of the matrix**
   g. **Sum of diagonal elements of a matrix**

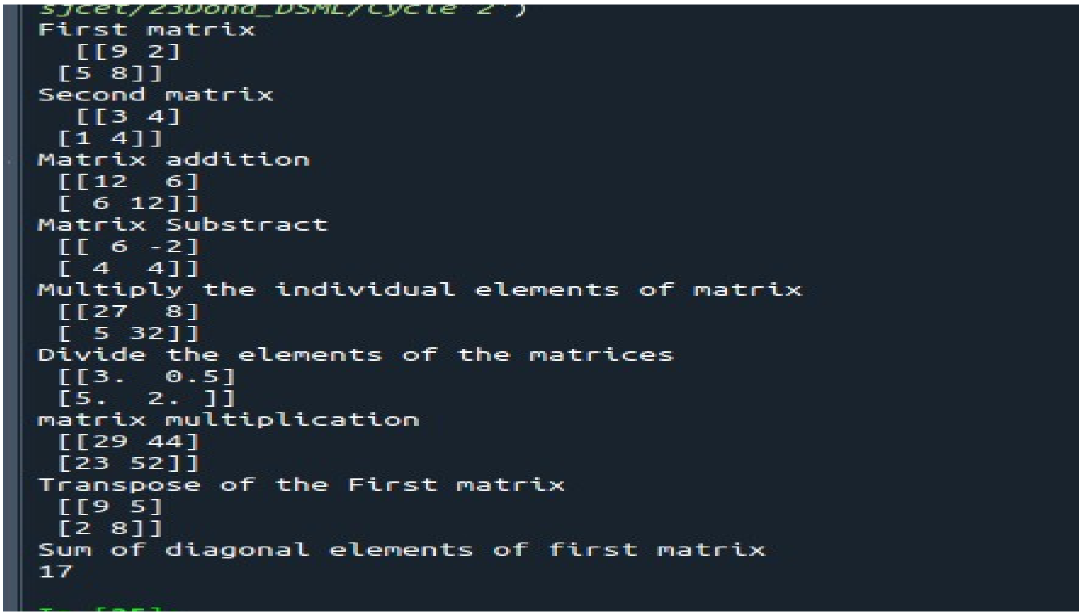
```
import numpy as np
M1 = np.array([[9, 2], [5, 8]])
M2 = np.array([[3, 4], [1, 4]])
print("First matrix \n ",M1)
print("Second matrix \n ",M2)
add = M1 + M2
print("Matrix addition\n",add)
sub = M1 - M2
print("Matrix Substract\n",sub)
mul = M1 * M2
print("Multiply the individual elements of matrix\n",mul)

div = M1 / M2
print("Divide the elements of the matrices\n",div)

M3 = M1.dot(M2)
print("matrix multiplication \n",M3)
```

```
tr = M1.transpose()
print("Transpose of the First matrix\n",tr)

print("Sum of diagonal elements of first matrix")
print(np.trace(M1))
```



```
First matrix
 [[9 2]
 [5 8]]
Second matrix
 [[3 4]
 [1 4]]
Matrix addition
 [[12  6]
 [ 6 12]]
Matrix Substract
 [[ 6 -2]
 [ 4  4]]
Multiply the individual elements of matrix
 [[27  8]
 [ 5 32]]
Divide the elements of the matrices
 [[3.  0.5]
 [5.  2. ]]
matrix multiplication
 [[29 44]
 [23 52]]
Transpose of the First matrix
 [[9 5]
 [2 8]]
Sum of diagonal elements of first matrix
17
```

8. Demonstrate the use of insert() function in 1D and 2D array.

```
import numpy as np

arr1 = np.arange(10, 16)
print("1D ARRAY ")
print("The array is: ", arr1)

obj = 2
value = 40
arr = np.insert(arr1, obj, value, axis=None)
print("After inserting the new array is: \n",arr)

print("Shape of the new array is : ", np.shape(arr))

print("2D ARRAY ")
arr1 = np.array([(1, 2, 3), (4, 5, 6), (7, 8, 9), (50, 51, 52)])
print("The array is: \n",arr1)

print("The shape of the array is: ", np.shape(arr1))
```

```
a = np.insert(arr1, 1, [[50], [100], ], axis=0)
print("New array is : \n",a)

print("Shape of the array is: ", np.shape(a))
```

```
1D ARRAY
The array is:  [10 11 12 13 14 15]
After inserting the new array is:
 [10 11 40 12 13 14 15]
Shape of the new array is :  (7,)
2D ARRAY
The array is:
 [[ 1  2  3]
 [ 4  5  6]
 [ 7  8  9]
 [50 51 52]]
The shape of the array is:  (4, 3)
New array is :
 [[  1   2   3]
 [ 50  50  50]
 [100 100 100]
 [  4   5   6]
 [  7   8   9]
 [ 50  51  52]]
Shape of the array is:  (6, 3)
```

9. Demonstrate the use of diag() function in 1D and 2D array.

```
import numpy as np
a= np.array([[3,6,7,8]])
b=np.array([[3,6,8,7], [4,2,1,0],[3,1,3,3],[1,1,2,2]])
print("1d array : ",a)
print("2D array \n",b)
print("diag() function")
x=np.diag(a)
y=np.diag(b)
print(x)
print(y)
```

```
home/sjcet/23Dona_DSML/Cycle 2')
1d array :  [[3 6 7 8]]
2D array
 [[3 6 8 7]
 [4 2 1 0]
 [3 1 3 3]
 [1 1 2 2]]
diag() function
[3]
[3 2 3 2]
```

10. Demonstarte the use of append() function in 1D and 2D array.

```
import numpy as np
a =  np.array([1,2,3])
b = np.array([[1,2,3],[4,5,6]])
print("First array:\n",a)
print("Second array\n",b)

print ("Append elements to array:")
print (np.append(a, [7,8,9]))
print (np.append(b, [7,8,9]))
```

```
First array:
 [1 2 3]
Second array
 [[1 2 3]
 [4 5 6]]
Append elements to array:
[1 2 3 7 8 9]
[1 2 3 4 5 6 7 8 9]
```

11. **Demonstarte the use of sum() function in 1D and 2D array.**

```
import numpy as np
a=np.array([4,5])
b=np.array([[1,2,3],[4,5,6]])
print("1D array\n",a)
print("2D array\n",b)
print("sum() function")
asum=np.sum(a)
print(asum)
bsum=np.sum(b)
print(bsum)
```

```
1D array
 [4 5]
2D array
 [[1 2 3]
 [4 5 6]]
sum() function
9
21
```

PART 2

1. **Create a square matrix with random integer values(use randint()) and use appropriate functions to find:**

   i) inverse
   ii) rank of matrix
   iii) Determinant
   iv) transform matrix into 1D array
   v) eigen values and vectors

```
import numpy as np
import numpy as nf
from numpy.linalg import eig
mat = np.random.randint(10, size=(3, 3))
array = nf.random.randint(10, size=(3, 3))
print("Square matrix \n",mat)

M_inverse = np.linalg.inv(mat)
print("Inverse of the matrix\n",M_inverse)

rank = np.linalg.matrix_rank(mat)
print("Rank of the given Matrix \n",rank)

det= np.linalg.det(mat)
print("Determinant of the given Matrix \n",det)

arr=mat.flatten()
print("Transform matrix to 1D array \n",arr)

w,v=eig(array)
print('Eigen value \n', w)
print('Eigen vector \n', v)
```

```
Square matrix
 [[3 4 2]
 [6 5 0]
 [7 8 9]]
Inverse of the matrix
 [[-0.81818182  0.36363636  0.18181818]
 [ 0.98181818 -0.23636364 -0.21818182]
 [-0.23636364 -0.07272727  0.16363636]]
Rank of the given Matrix
 3
Determinant of the given Matrix
 -54.999999999999964
Transform matrix to 1D array
 [3 4 2 6 5 0 7 8 9]
Eigen value
 [ 8.80165105  0.11679014 -2.91844118]
Eigen vector
 [[-0.50675971 -0.60678131 -0.07810574]
 [-0.68511425  0.79299868 -0.75150289]
 [-0.52327149  0.0544935   0.65508999]]
```

2. Create a matrix X with suitable rows and columns

i) Display the cube of each element of the matrix using different methods

(use multiply(), *, power(),)**

ii) Display identity matrix of the given square matrix

iii) Display each element of the matrix to different powers.

iv) Create a matrix Y with same dimension as X and perform the operation X^2+2Y

```
import numpy as np
mat =np.array([[1, 2, 3],[3,2,4],[2,2,1]])
print("Matrix is....\n",mat)

print("Cubes using *")
print(mat*mat*mat)

print("Cubes using **")
print(mat**3)

print("Cubes using multiply()")
print(np.multiply(mat,(mat*mat)))

print("Cubes using power()")
print(np.power(mat,3))
print(pow(mat, 3))
```

```
b = np.identity(3, dtype = int)
print("Identity matrix:\n", b)

out = np.power(mat, mat)
print("Each element of the matrix to different powers:\n",out)

x = np.arange(1,10).reshape(3,3)
y = np.arange(11,20).reshape(3,3)
print("matrix x \n", x ,"\n Matrix y\n",y)
print("perform the operation X∧2 +2Y: \n",np.add((np.power(x,2)),
(np.multiply(y,2))))
```

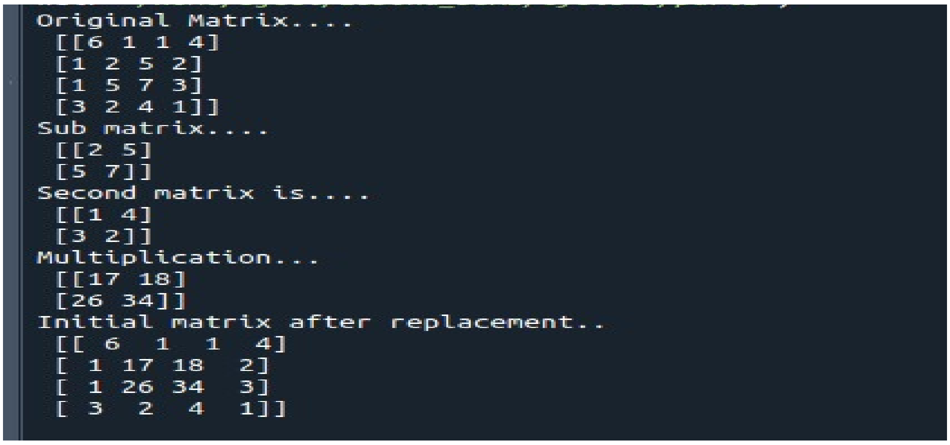
```
Matrix is....
 [[1 2 3]
 [3 2 4]
 [2 2 1]]
Cubes using *
[[ 1  8 27]
 [27  8 64]
 [ 8  8  1]]
Cubes using **
[[ 1  8 27]
 [27  8 64]
 [ 8  8  1]]
Cubes using multiply()
[[ 1  8 27]
 [27  8 64]
 [ 8  8  1]]
Cubes using power()
[[ 1  8 27]
 [27  8 64]
 [ 8  8  1]]
[[ 1  8 27]
 [27  8 64]
 [ 8  8  1]]
```

```
 [ 8  8  1]]
Identity matrix:
 [[1 0 0]
 [0 1 0]
 [0 0 1]]
Each element of the matrix to different powers:
 [[  1   4  27]
 [ 27   4 256]
 [  4   4   1]]
matrix x
 [[1 2 3]
 [4 5 6]
 [7 8 9]]
 Matrix y
 [[11 12 13]
 [14 15 16]
 [17 18 19]]
perform the operation X^2 +2Y:
 [[ 23  28  35]
 [ 44  55  68]
 [ 83 100 119]]
```

3. **Multiply a matrix with a submatrix of another matrix and replace the same in larger matrix.**

$$\begin{bmatrix} a_{00} & a_{01} & a_{02} & a_{03} & a_{04} & a_{05} \\ a_{10} & a_{11} & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{20} & a_{21} & a_{22} & a_{23} & a_{24} & a_{25} \\ a_{30} & a_{31} & a_{32} & a_{33} & a_{34} & a_{35} \\ a_{40} & a_{41} & a_{42} & a_{43} & a_{44} & a_{45} \end{bmatrix} \quad \begin{bmatrix} b_{00} & b_{01} & b_{02} \\ b_{10} & b_{11} & b_{12} \\ b_{20} & b_{21} & b_{22} \end{bmatrix}$$

```
import numpy as np
mat = np.array([[6, 1, 1, 4],
                [1, 2, 5, 2],
                [1, 5, 7, 3],
                [3, 2, 4, 1]])
print("Original Matrix....\n",mat)
sub = mat[1:3, 1:3]
print("Sub matrix....\n",sub)
mat2 = np.array([[1, 4],
                [3, 2]])
print("Second matrix is....\n",mat2)
mul=np.dot(sub,mat2)
print("Multiplication...\n",mul)
mat[1:3, 1:3] = mul
print("Initial matrix after replacement..\n",mat)
```



```
Original Matrix....
 [[6 1 1 4]
 [1 2 5 2]
 [1 5 7 3]
 [3 2 4 1]]
Sub matrix....
 [[2 5]
 [5 7]]
Second matrix is....
 [[1 4]
 [3 2]]
Multiplication...
 [[17 18]
 [26 34]]
Initial matrix after replacement..
 [[ 6  1  1  4]
 [ 1 17 18  2]
 [ 1 26 34  3]
 [ 3  2  4  1]]
```

4. Given 3 Matrices A, B and C. Write a program to perform matrix multiplication of the 3 matrices.

```
import numpy as np
M1 = np.array([[3, 6], [4, 2]])
M2 = np.array([[9, 2], [1, 2]])
M3=np.array([[2,4],[3,1]])
Mul = M1.dot(M2)
mul1=M3.dot(Mul)
print("Matrix1:\n",M1)
print("Matrix2:\n",M2)
print("Matrix3:\n",M3)
print("multiplication of 3 matrices\n",mul1)
```

```
Matrix1:
 [[3 6]
 [4 2]]
Matrix2:
 [[9 2]
 [1 2]]
Matrix3:
 [[2 4]
 [3 1]]
multiplication of 3 matrices
 [[218  84]
 [137  66]]
```

5. Write a program to check whether given matrix is symmetric or Skew Symmetric.

Solving systems of equations with numpy

One of the more common problems in linear algebra is solving a matrix-vector equation.
Here is an example. We seek the vector x that solves the equation
A X = b

where
$$A = \begin{bmatrix} 2 & 1 & -2 \\ 3 & 0 & 1 \\ 1 & 1 & -1 \end{bmatrix} \qquad \mathbf{b} = \begin{bmatrix} -3 \\ 5 \\ -2 \end{bmatrix}$$

And $X=A^{-1}b$.

Numpy provides a function called solve for solving such eauations.

```
import numpy as np
A = np.array([[6, 1, 1],
              [1, -2, 5],
              [1, 5, 7]])
print("Original Matrix\n",A)
inv=np.transpose(A)
print ("Transpose matrix\n",inv)
neg=np.negative(A)
comparison = A == inv
comparison1 = inv== neg
equal_arrays = comparison.all()
skew=comparison1.all()
if equal_arrays :
```

```
    print("Symmetric")
else:
    print("not Symmetric")

if skew:
    print("Skew Symmetric")
else:
    print("Not Skew Symmetric")
```

```
Original Matrix
 [[ 6  1  1]
 [ 1 -2  5]
 [ 1  5  7]]
Transpose matrix
 [[ 6  1  1]
 [ 1 -2  5]
 [ 1  5  7]]
Symmetric
Not Skew Symmetric
```

6. Write a program to find out the value of X using solve(), given A and b as above

```
import numpy as np
A = np.array([[2, 1, -2],
              [3, 0, 1],
              [1, 1, -1]])
b=np.array([[3],
            [5],
            [-2]])
inv=np.linalg.inv(A)
x=np.linalg.solve(inv,b)
print(x)
```

```
[[15.]
 [ 7.]
 [10.]]

In [41]:
```

7. Write a program to perform the SVD of a given matrix. Also reconstruct the given matrix from the 3 matrices obtained after performing SVD.

```
from numpy import array
from scipy.linalg import svd
from numpy import diag
from numpy import dot
from numpy import zeros
# define a matrix
A = array([[1, 2], [3, 4], [5, 6]])
print(A)
# SVD
U, s, VT = svd(A)
print("first" ,U)
print("second",s)
print("3rd" ,VT)
Sigma = zeros((A.shape[0], A.shape[1]))
# populate Sigma with n x n diagonal matrix
Sigma[:A.shape[1], :A.shape[1]] = diag(s)
# reconstruct matrix
B = U.dot(Sigma.dot(VT))
print(B)
```

```
[[1 2]
 [3 4]
 [5 6]]
first [[-0.2298477   0.88346102  0.40824829]
 [-0.52474482  0.24078249 -0.81649658]
 [-0.81964194 -0.40189603  0.40824829]]
second [9.52551809 0.51430058]
3rd [[-0.61962948 -0.78489445]
 [-0.78489445  0.61962948]]
[[1. 2.]
 [3. 4.]
 [5. 6.]]
```