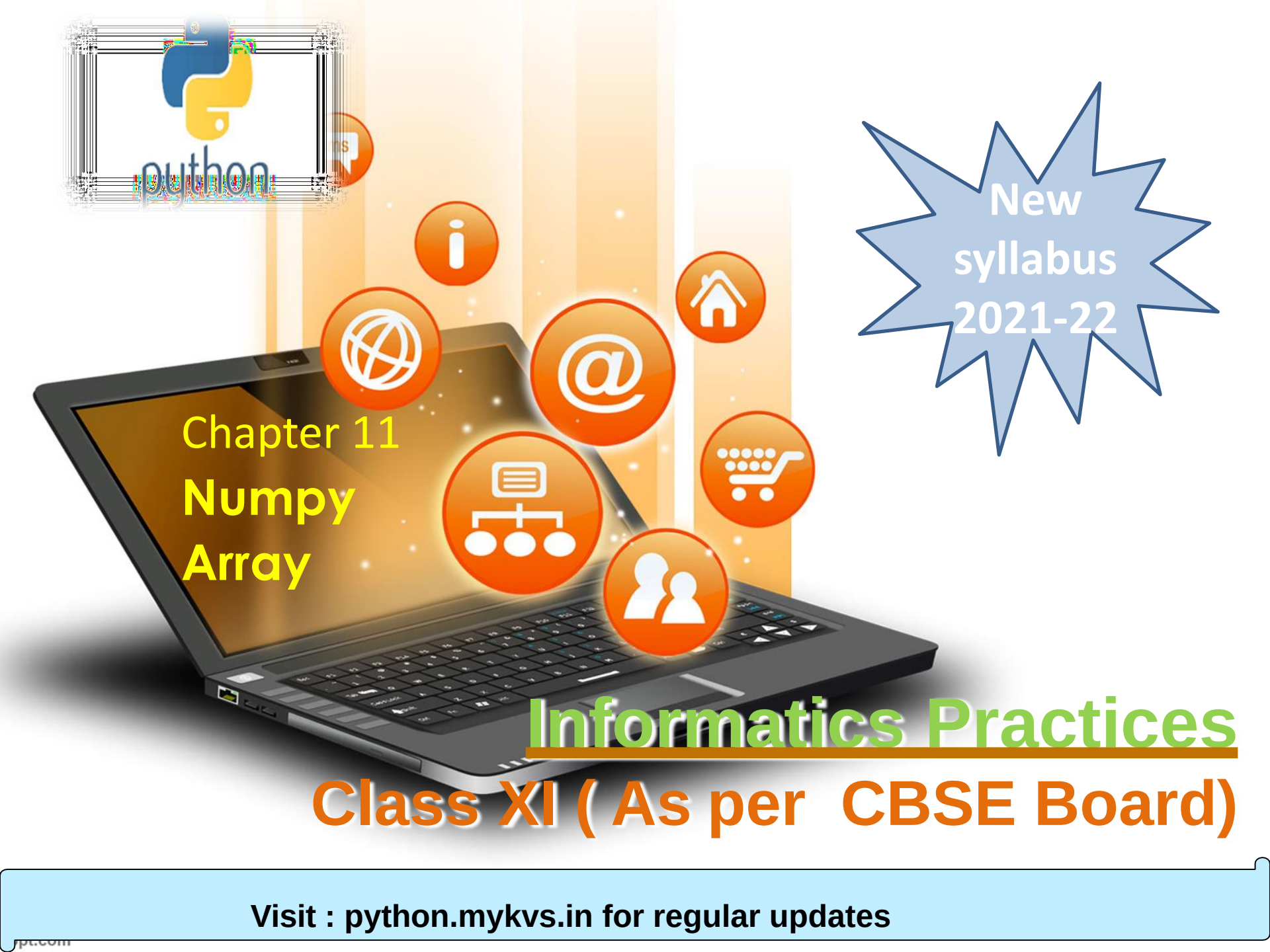
python
New syllabus 2021-22
Chapter 11
Numpy Array
Informatics Practices
Class XI (As per CBSE Board)
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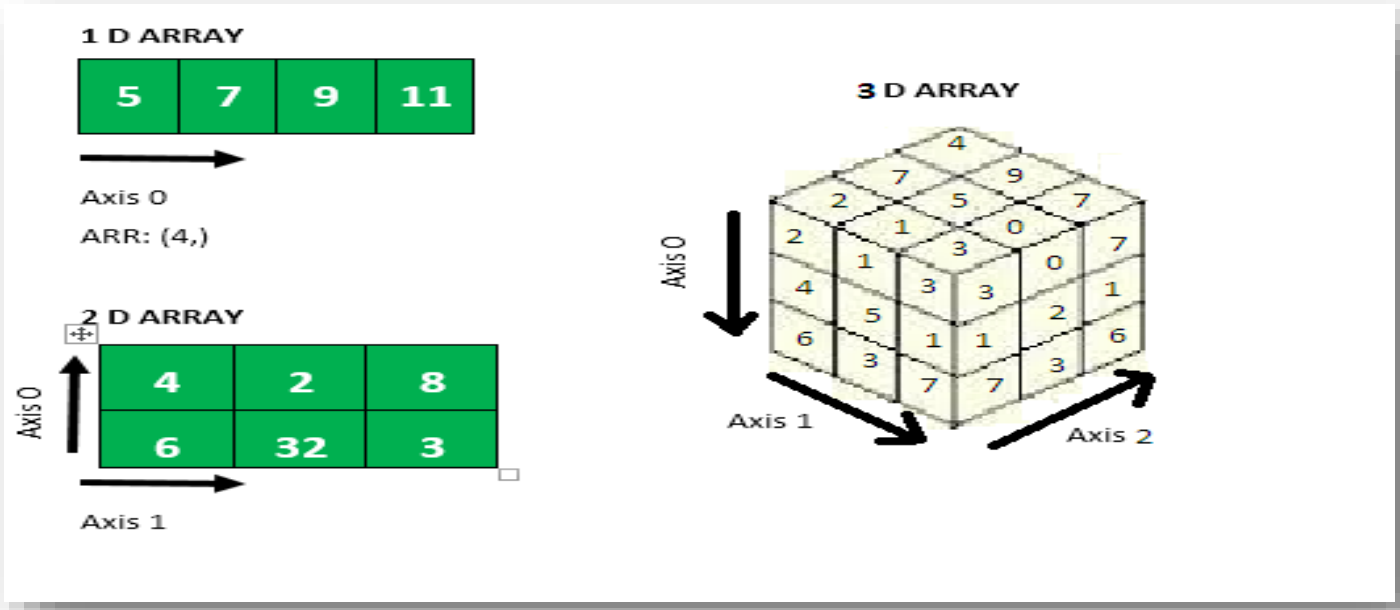
NUMPY - ARRAY

NumPy stands for Numerical Python.It is the core library for scientific computing in Python. It consist of multidimensional array objects, and tools for working with these arrays.

Numpy Array is a grid of values with same type, and is indexed by a tuple of nonnegative integers. The number of dimensions of it ,is the rank of the array; the shape of an array depends upon a tuple of integers giving the size of the array along each dimension.



Note:- Befor numpy based programming ,it must be installed. It can be installed using >pip install numpy command at command prompt

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NUMPY - ARRAY

Advantage of using Numpy Array

- Contiguous allocation in memory
- Vectorized operations
- Boolean selection
- Sliceability

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NUMPY - ARRAY

Difference between Numpy array and list

NUMPY ARRAY	LIST
Numpy Array works on homogeneous types	Python list are made for heterogeneous types
Python list support adding and removing of elements	numpy.Array does not support adding and removing of elements
Can’t contain elements of different types	can contain elements of different types
smaller memory consumption	more memory consumption
better runtime	Runtime not speedy

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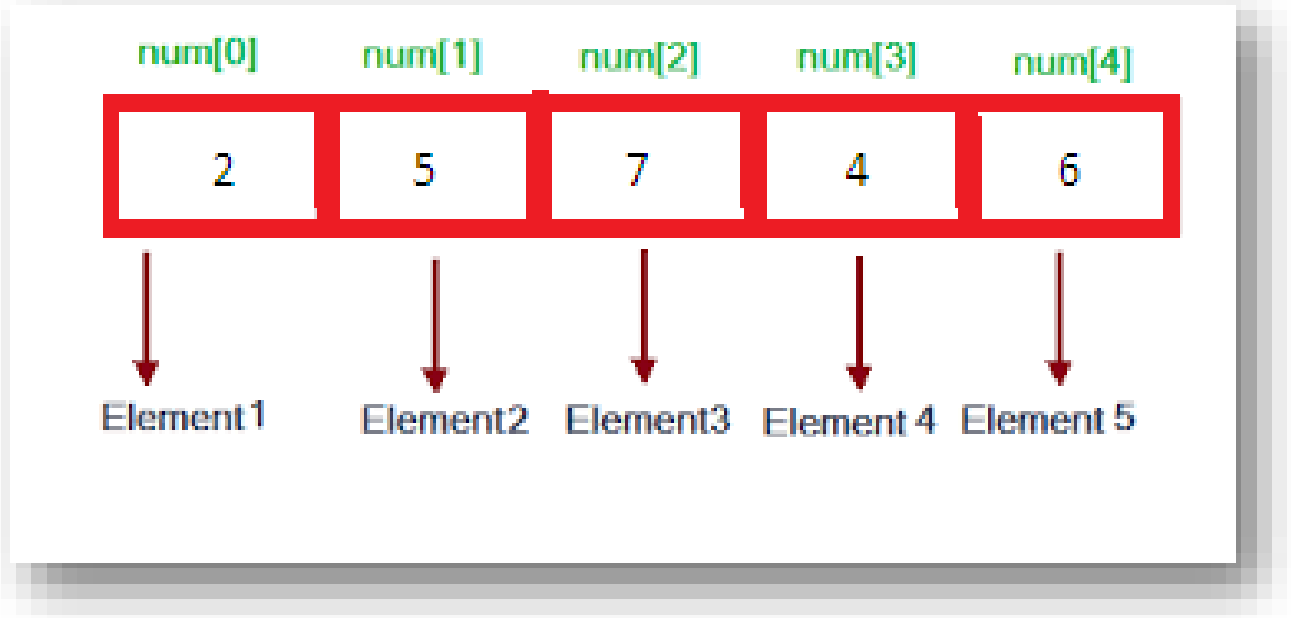
NUMPY - ARRAY

1 D ARRAY

Any arrays can be single or multidimensional. The number of subscript/index determines dimensions of the array. An array of one dimension is known as a one-dimensional array or 1-D array



In above diagram num is an array ,it's first element is at 0 index position ,next element is at 1 and so on till last element at n-1 index position.At 0 index position value is 2 and at 1 index position value is 5.

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NUMPY - ARRAY

1 D ARRAY

Creation of 1D array

One dimension array can be created using array method with list object with one dimensional elements.

e.g.program

```
import numpy as np
a = np.array([500, 200, 300])        # Create a 1D Array
print(type(a))                       # Prints "<class 'numpy.ndarray'>"
print(a.shape)                       # Prints "(3,)" means dimension of array
print(a[0], a[1], a[2])              # Prints "500 200 300"
a[0] = 150                           # Change an element of the array
print(a)
```


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NUMPY - ARRAY

1 D ARRAY

Creation of 1D array Using functions

```
import numpy as np
p = np.empty(5)     # Create an array of 5 elements with random values
print(p)

a1 = np.zeros(5)     # Create an array of all zeros float values
print(a1)          # Prints "[0. 0. 0. 0. 0.]"

a2 = np.zeros(5, dtype = np.int)     # Create an array of all zeros int values
print(a2)          # Prints "[0. 0. 0. 0. 0.]"

b = np.ones(5)      # Create an array of all ones
print(b)         # Prints "[1. 1. 1. 1. 1.]"

c = np.full(5, 7)   # Create a constant array
print(c)           # Prints "[7 7 7 7 7]"

e = np.random.random(5)      # Create an array filled with random values
print(e)
```


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NUMPY - ARRAY

1 D ARRAY

Create 1D from string

```
import numpy as np
data =np.fromstring('1 2', dtype=int, sep=' ')
print(data)
```

Note:- in fromstring dtype and sep argument can be changed.

Create 1D from buffer

numpy array from range

```
numpy.arange(start, stop, step, dtype)
#program 1
import numpy as np
x = np.arange(5) #for float value specify dtype = float as argument
print(x)   #print [0  1  2  3  4]
#program 2
import numpy as np
x = np.arange(10,20,2)
print (x) #print [10  12  14  16  18]
```


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NUMPY - ARRAY

1 D ARRAY

Create 1D from array

Copy function is used to create the copy of the existing array.

e.g.program

```
import numpy as np
x = np.array([1, 2, 3])
y = x
z = np.copy(x)
x[0] = 10
print(x)
print(y)
print(z)
```

Note that, when we modify x, y changes, but not z:

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NUMPY - ARRAY

1 D ARRAY SLICES

Slicing of numpy array elements is just similar to slicing of list elements.

e.g.program

```
import numpy as np
data = np.array([5,2,7,3,9])
print (data[:]) #print [5 2 7 3 9]
print(data[1:3])        #print [2 7]
print(data[:2])         #print [5 2]
print(data[-2:])        #print [3 9]
```


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NUMPY - ARRAY

1 D ARRAY JOINING

Joining of two or more one dimensional array is possible with the help of concatenate() function of numpy object.

e.g.program

```
import numpy as np
a = np.array([1, 2, 3])
b = np.array([5, 6])
c=np.concatenate([a,b,a])
print(c) #print [1 2 3 5 6 1 2 3]
```


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NUMPY - ARRAY

Print all subsets of a 1D Array

If A {1, 3, 5}, then all the possible/proper subsets of A are { }, {1}, {3}, {5}, {1, 3}, {3, 5}

e.g.program

```
import pandas as pd
import numpy as np
def sub_lists(list1):
    # store all the sublists
    sublist = [[]]
    # first loop
    for i in range(len(list1) + 1):
        # second loop
        for j in range(i + 1, len(list1) + 1):
            # slice the subarray
            sub = list1[i:j]
            sublist.append(sub)
    return sublist
x = np.array([1, 2, 3,4])
# driver code
print(sub_lists(x))
```

OUTPUT

[[], array([1]), array([1, 2]),
array([1, 2, 3]), array([1, 2, 3, 4]),
array([2]), array([2, 3]), array([2, 3, 4]),
array([3]), array([3, 4]), array([4])]

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NUMPY - ARRAY

Basic arithmetic operation on 1D Array e.g.program

```
import numpy as np
x = np.array([1, 2, 3,4])
y = np.array([1, 2, 3,4])
z=x+y
print(z) #print [2 4 6 8]
z=x-y
print(z) #print [0 0 0 0]
z=x*y
print(z) #print [ 1  4  9 16]
z=x/y
print(z) #print [1. 1. 1. 1.]
z=x+1
print(z) #print [2 3 4 5]
```

Aggregate operation on 1D Array e.g.program

```
import numpy as np
from scipy import stats
x = np.array([1, 2,3, 3,4])
print(x.sum()) #print 13
print(x.min()) #print 1
print(x.max()) #print 4
print(x.mean())#print 2.6
print(np.median(x))#print 3.0
print(x.size)#count no of elements 5
print(stats.mode(x))
#ModeResult(mode=array([3]),
count=array([2]))
print(np.std(x))#1.019803902718557
print(np.var(x))#1.040000000000003
```


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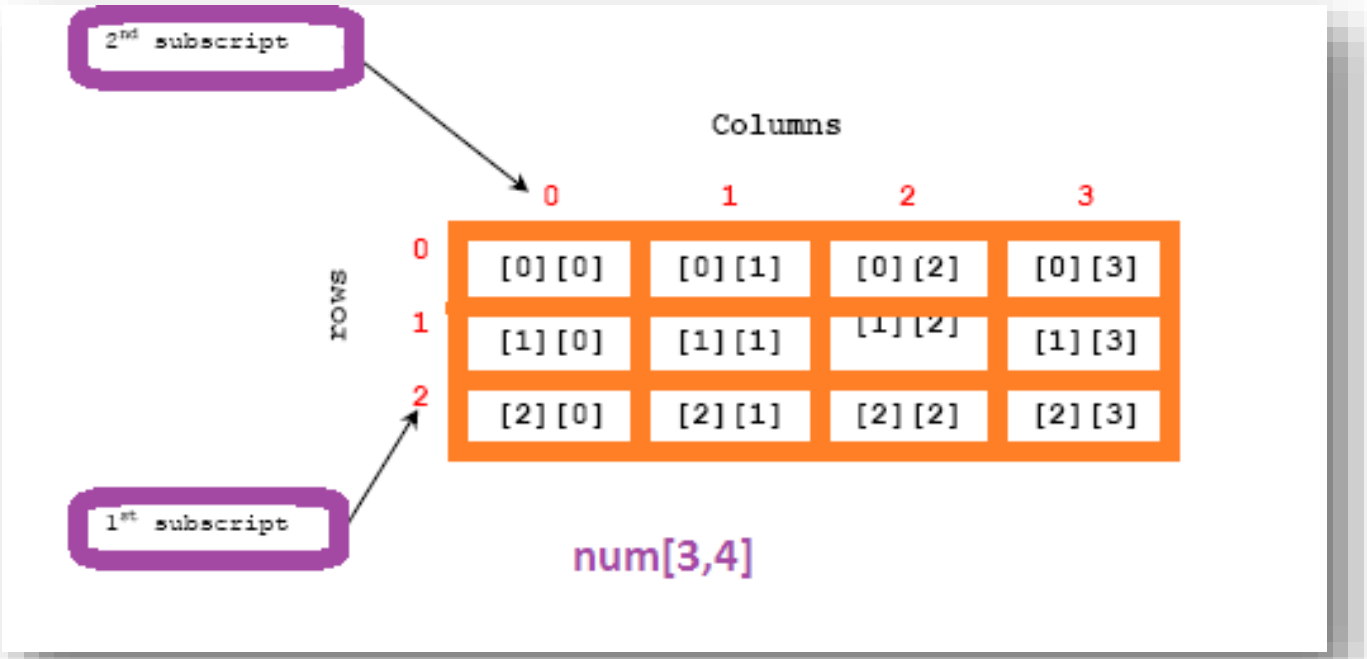
NUMPY - ARRAY

2 D ARRAY

An array of one dimension/index/subscript is known as a one-dimensional array or 1-D array



In above diagram num is an array of two dimension with 3 rows and 4 columns.subscript of rows is 0 to 2 and columns is 0 to 3.

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NUMPY - ARRAY

2 D ARRAY

Creation of 2D array

Two dimension array can be created using array method with list object with two dimensional elements.

e.g.program

```
import numpy as np
a = np.array([[3, 2, 1],[1, 2, 3]])          # Create a 2D Array
print(type(a))                               # Prints "<class 'numpy.ndarray'>"
print(a.shape)                               # Prints (2, 3)
print(a[0][1])                               # Prints 2
a[0][1] = 150                                # Change an element of the array
print(a)                                     # prints [[  3 150   1] [  1   2   3]]
```


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NUMPY - ARRAY

2 D ARRAY

Creation of 2D array Using functions

```
import numpy as np
p = np.empty([2,2])     # Create an array of 4 elements with random values
print(p)

a1 = np.zeros([2,2])     # Create 2d array of all zeros float values
print(a1)          # Prints [[0. 0.][0. 0.]]

a2 = np.zeros([2,2], dtype = np.int)     # Create an array of all zeros int values
print(a2)          # Prints [[0 0] [0 0]]

b = np.ones([2,2])      # Create an array of all ones
print(b)         # Prints [[1. 1.] [1. 1.]]

c = np.full([2,2], 7)   # Create a constant array
print(c)           # Prints [[7 7] [7 7]]

e = np.random.random([2,2])           # Create 2d array filled with random values
print(e)
```


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NUMPY - ARRAY

2D ARRAY

Creation of 2D array from 1D array

We can create 2D array from 1d array using reshape() function.

e.g. program

```
import numpy as np
A = np.array([1,2,3,4,5,6])
B = np.reshape(A, (2, 3))
print(B)
```

OUTPUT

```
[[1 2 3]
 [4 5 6]]
```


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NUMPY - ARRAY

2 D ARRAY SLICES

Slicing of numpy 2d array elements is just similar to slicing of list elements with 2 dimension.

e.g.program

```
import numpy as np
A = np.array([[7,  5,  9,  4],
      [ 7,  6,  8,  8],
      [ 1,  6,  7,  7]])
print(A[:2, :3])       #print elements of 0,1 rows and 0,1,2 columns
print(A[:3, ::2])      #print elements of 0,1,2 rows and alternate column position
print(A[::-1, ::-1])   #print elements in reverse order
print(A[:, 0])         #print all elements of 0 column
print(A[0, :])         #print all elements of 0 rows
print(A[0])            #print all elements of 0 row
```


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NUMPY - ARRAY

2 D ARRAY JOINING

e.g.program

```
import numpy as np
A = np.array([[7,  5],
              [1,  6]])
# concatenate along the first axis
print(np.concatenate([A, A]))
# concatenate along the second axis
(zero-indexed)

print(np.concatenate([A, A], axis=1))
x = np.array([1, 2])
# vertically stack the arrays
print(np.vstack([x, A]))
# horizontally stack the arrays
y = np.array([[99],
              [99]])
print(np.hstack([A, y]))
```

OUTPUT

```
[[7 5]
 [1 6]
 [7 5]
 [1 6]]

[[7 5 7 5]
 [1 6 1 6]]

[[1 2]
 [7 5]
 [1 6]]

[[ 7  5 99]
 [ 1  6 99]]
```


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NUMPY - ARRAY

2 D ARRAY ARITHMATIC OPERATION

Arithmetic operation over 2d array is possible with add,substract,multiply,divide () functions.

E.G.PROGRAM

```
import numpy as np
a = np.array([[7,  5,  9],
      [ 2,  6,  8]])
print(a)
b = np.array([10,10,10])
c=np.add(a,b) # c=a+b, similar
print(c)
c=np.subtract(a,b) # c=a-b, similar
print(c)
c=np.multiply(a,b) # c=a*b, similar
print(c)
c=np.divide(a,b) # c=a/b, similar
print(c)
```

OUTPUT

```
[[7 5 9]
 [2 6 8]]

[[17 15 19]
 [12 16 18]]

[[-3 -5 -1]
 [-8 -4 -2]]

[[70 50 90]
 [20 60 80]]

[[0.7 0.5 0.9]
 [0.2 0.6 0.8]]
```

Note:-

1. if both 2d arrays are with same dimension[matrix form] then one to one arithmetic operation will be performed.
2. No of elements of a dimension must match otherwise error message thrown

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NUMPY - ARRAY

2 D ARRAY - ARITHMATIC OPERATION

Arithmetic operation over 2d array can be done with single value also.

E.G.PROGRAM

```
import numpy as np
a = np.array([[7,  5,  9],
      [ 2,  6,  8]])
print(a)
c=np.add(a,2)
print(c)
c=np.subtract(a,2)
print(c)

c=np.multiply(a,2)
print(c)

c=np.divide(a,2)
print(c)
```

OUTPUT

```
[[7 5 9]
 [2 6 8]]

[[ 9  7 11]
 [ 4  8 10]]

[[5 3 7]
 [0 4 6]]

[[14 10 18]
 [ 4 12 16]]

[[3.5 2.5 4.5]
 [1.  3.  4. ]]
```


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NUMPY - ARRAY

2 D ARRAY – Mathematical Functions

Maths functions like power,abs,ceil,floor,around and trigonometric functions like sin,cos,tan,asin etc are supported by numpy

E.G.PROGRAM

```
import numpy as np
a = np.array([[7.333,  5.223],
      [ 2.572,  6.119]])
print(np.power(a,2))
```

OUTPUT

```
[[53.772889 27.279729]
 [ 6.615184 37.442161]]
```

```
print(np.ceil(a))
```

```
[[8. 6.]
 [3. 7.]]
```

```
print(np.floor(a))
```

```
[[7. 5.]
 [2. 6.]]
```

```
print(np.around(a,1))
```

```
[[7.3 5.2]
 [2.6 6.1]]
```


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NUMPY - ARRAY

2 D ARRAY – Statistical functions

```
import numpy as np
from scipy import stats
a = np.array([[1, 2], [3, 4]])
print(np.sum(a))                #10
print(np.sum(a, axis=0))        #[4 6]
print(np.size(a))               #4
print(np.size(a, axis=0))       #2
print(np.max(a))                #4
print(np.max(a, axis=0))        #[3 4]
print(np.mean(a))               #2.5
print(np.mean(a, axis=0))       #[2. 3.]
print(np.median(a))             #2.5
print(np.median(a, axis=0))     #[2. 3.]
print(np.std(a))                #1.118033988749895
print(np.std(a, axis=0))        #[1. 1.]
print(np.var(a))                #1.25
print(np.var(a, axis=0))        #[1. 1.]
print(stats.mode(a))            #ModeResult(mode=array([[1, 2]]), count=array([[1, #1
print(stats.mode(a, axis=0))    ModeResult(mode=array([[1, 2]]), count=array([[1, 1]])
```


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