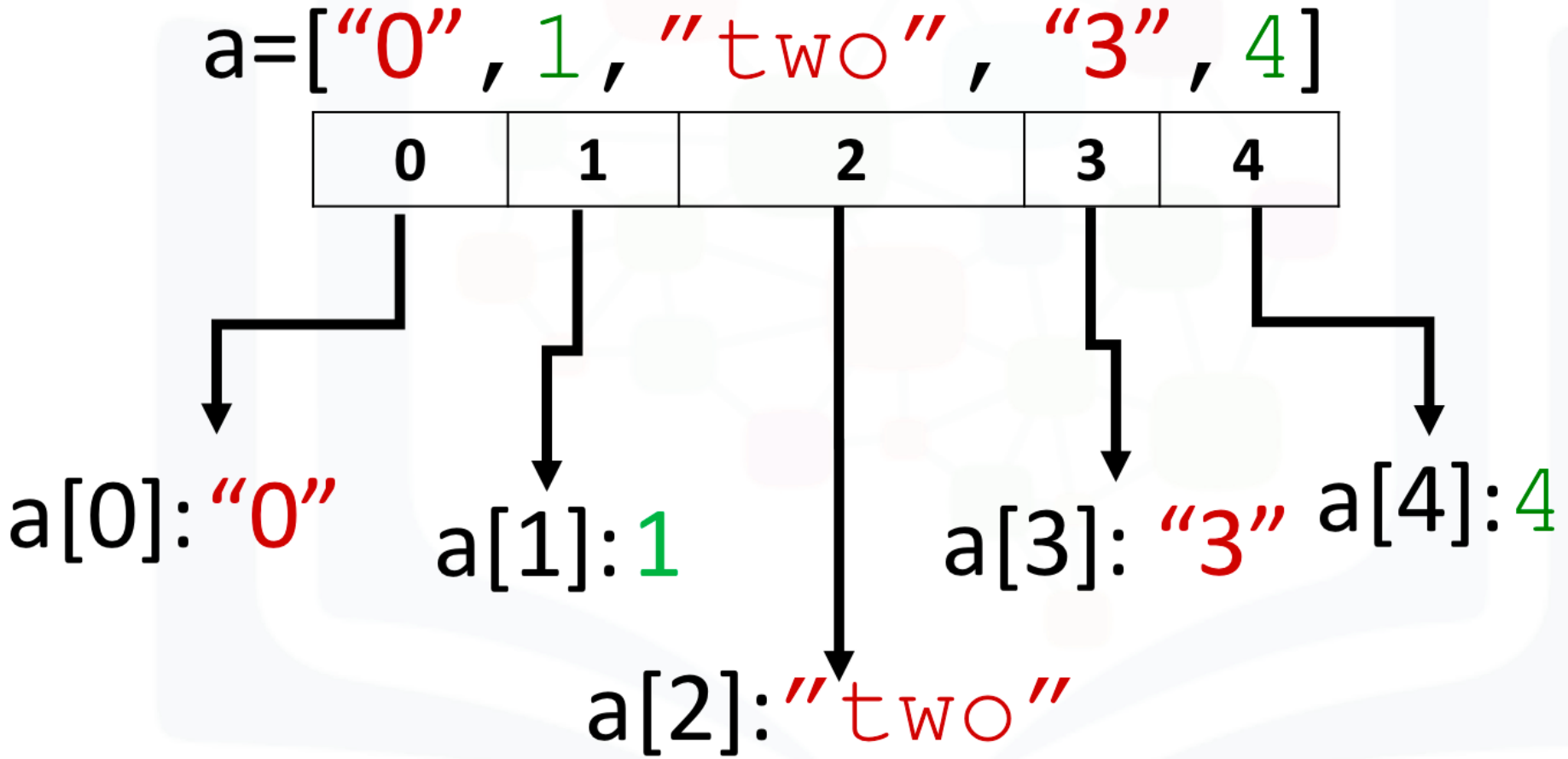
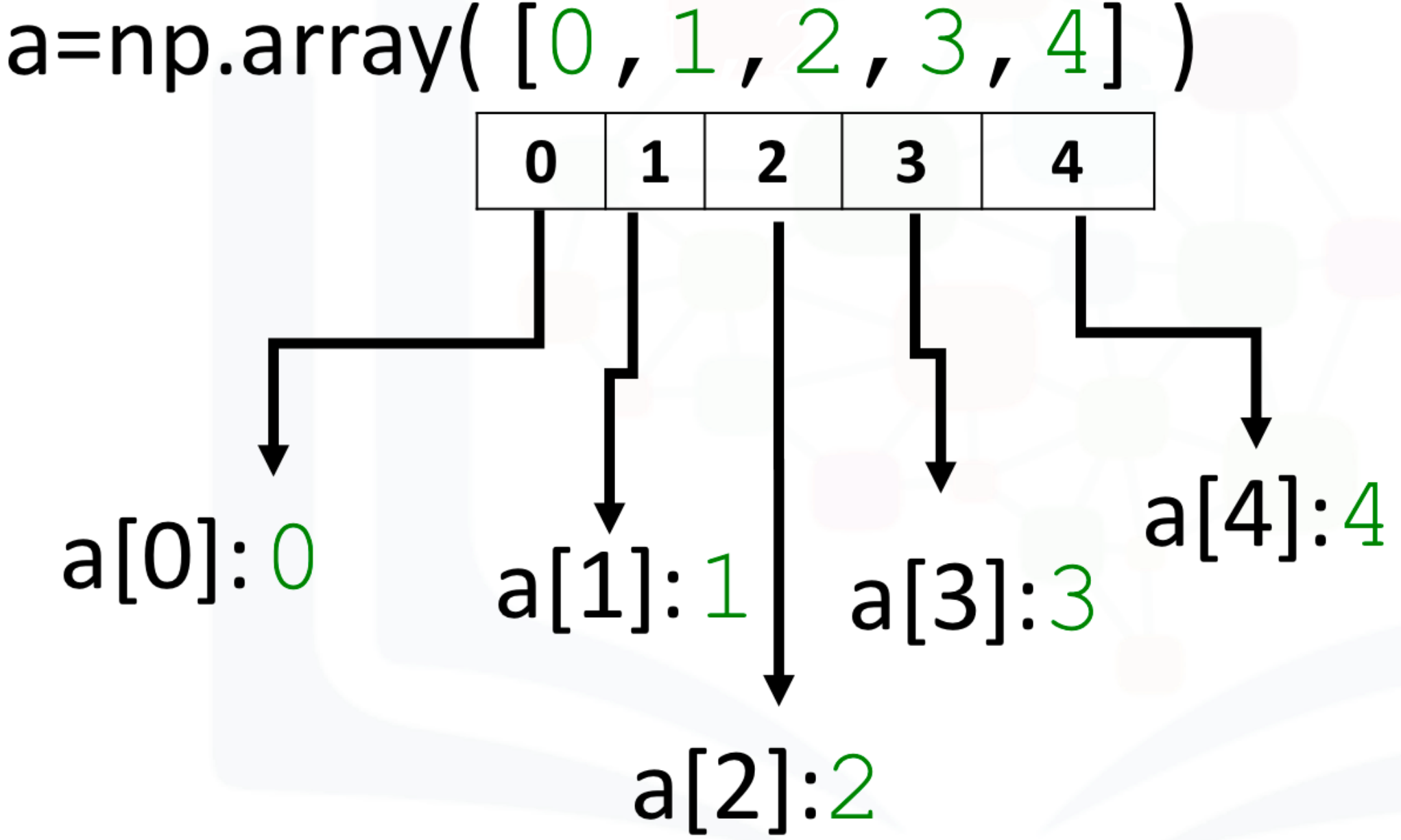
st
1 part:
1D Arrays


a=["0", 1, "two", "3", 4]
0
1
2
3
4
a[0]: "0"
a[1]: 1
a[2]: "two"
a[3]: "3"
a[4]: 4

```
a:array([0,1,2,3, 4])
type(a): numpy.ndarray
a.dtype:dtype('int64')
```


a=np.array([0,1,2,3,4])
0
1
2
3
4
a[0]:0
a[1]:1
a[2]:2
a[3]:3
a[4]:4

نوع!

```
a:array([0,1,2,3, 4])
type(a): numpy.ndarray
a.dtype:dtype('int64')
```

برخی از ویژگی ها

```
a=np.array( [0,1,2,3,4] )
```

a.size :5

a.ndim: 1

a.shape: (5,)

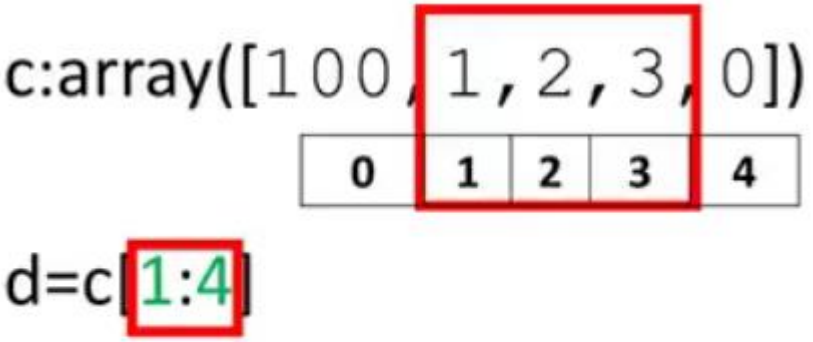
آرایه ای از اعداد اعشاری

```
b=np.array([3.1,11.02,6.2, 213.2,5.2])

type(b): numpy.ndarray
b.dtype:dtype('float64')
```

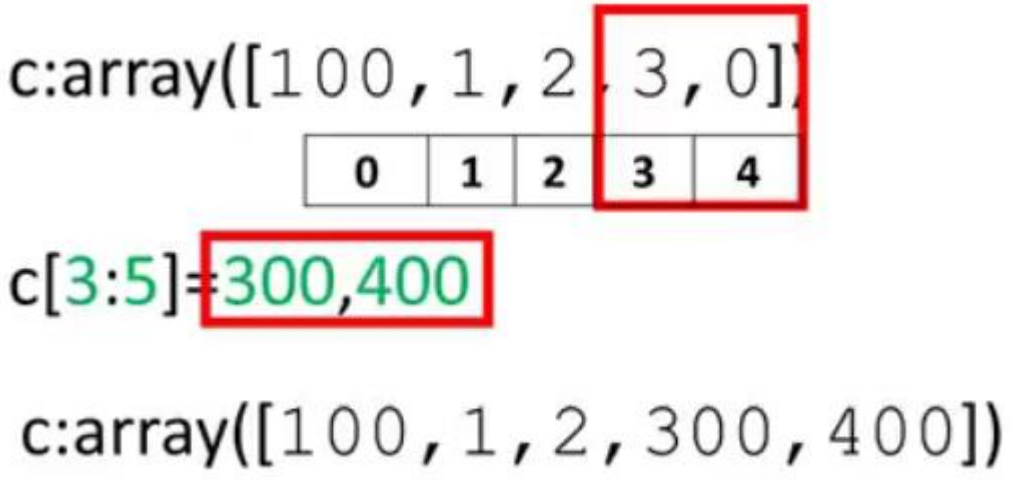
Indexing and slicing

```
c=np.array([20,1,2,3, 4])
c:array([20,1,2,3, 4])

c[0]=100
c:array([100,1,2,3,4])

c[4]=0
c:array([100,1,2,3,0])
```

slicing



slicing

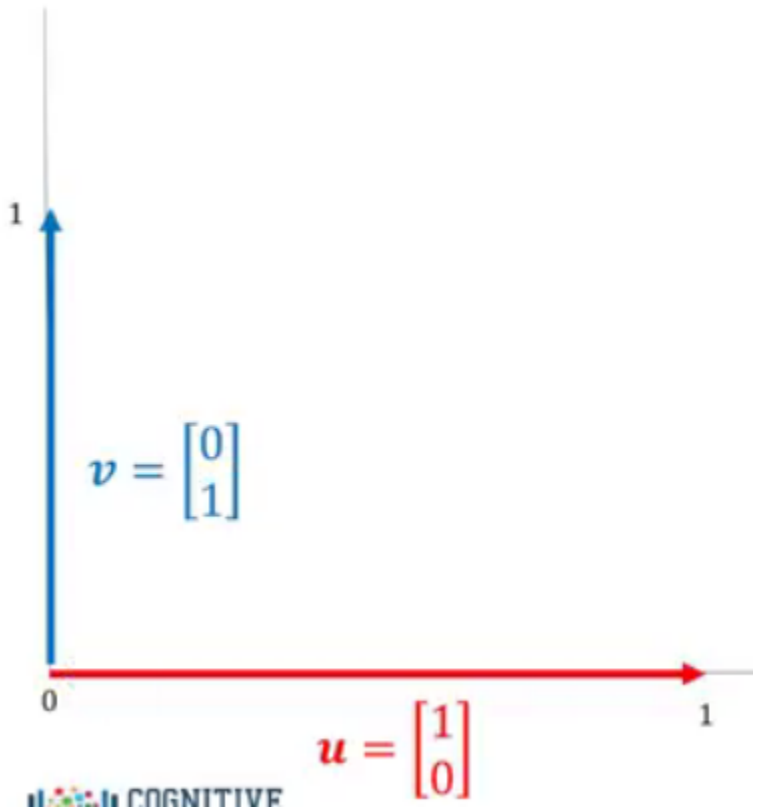


Basic Operations

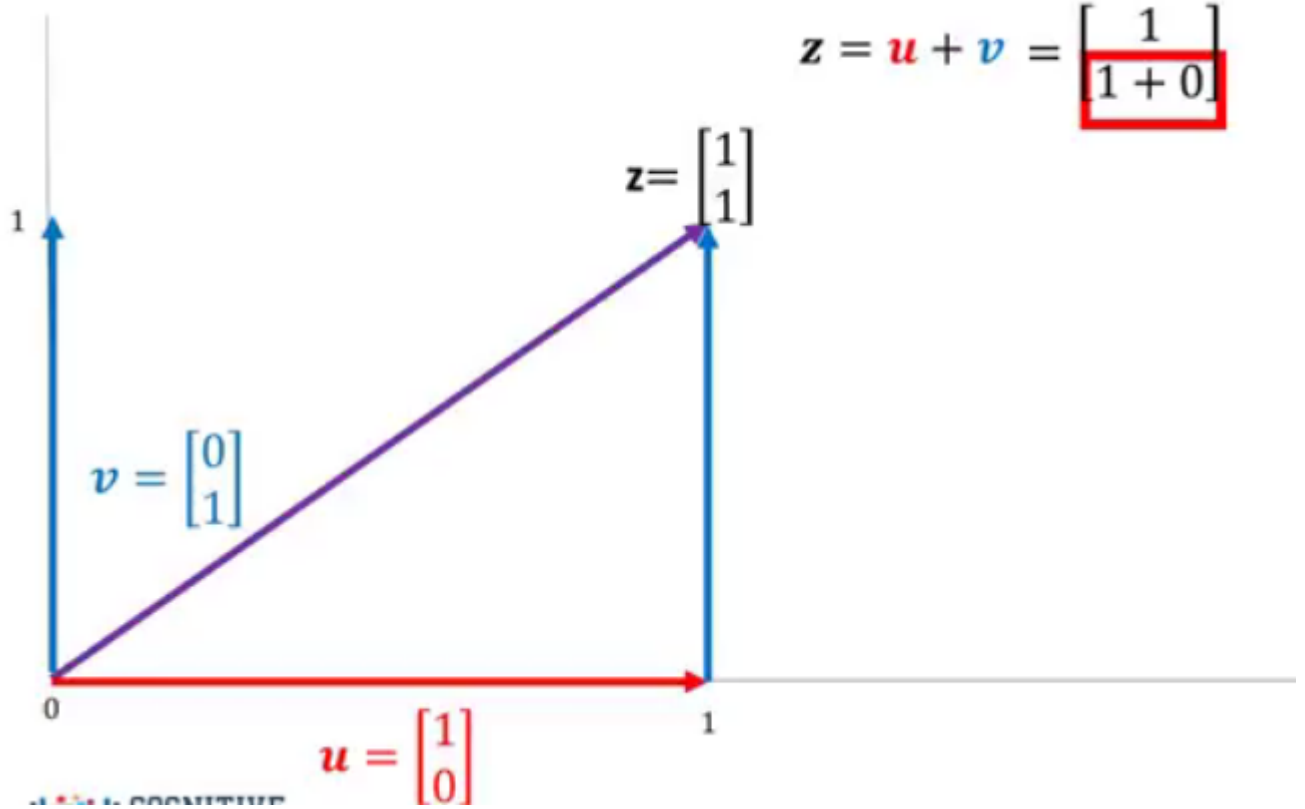
Vector addition and subtraction

$$u = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad v = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$z = u + v = \begin{bmatrix} 1+0 \\ 0+1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$


1
$v = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$
0
1
$u = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$$z = u + v = \begin{bmatrix} 1 \\ 1+0 \end{bmatrix}$$



```
u=np.array([1,0])
v=np.array([0,1])

z=u+v

z:array([1, 1])
```

```
u=[1,0]
v=[0,1]
z=[ ]

for n, m in zip(u,v):

    z.append(n+m)
```

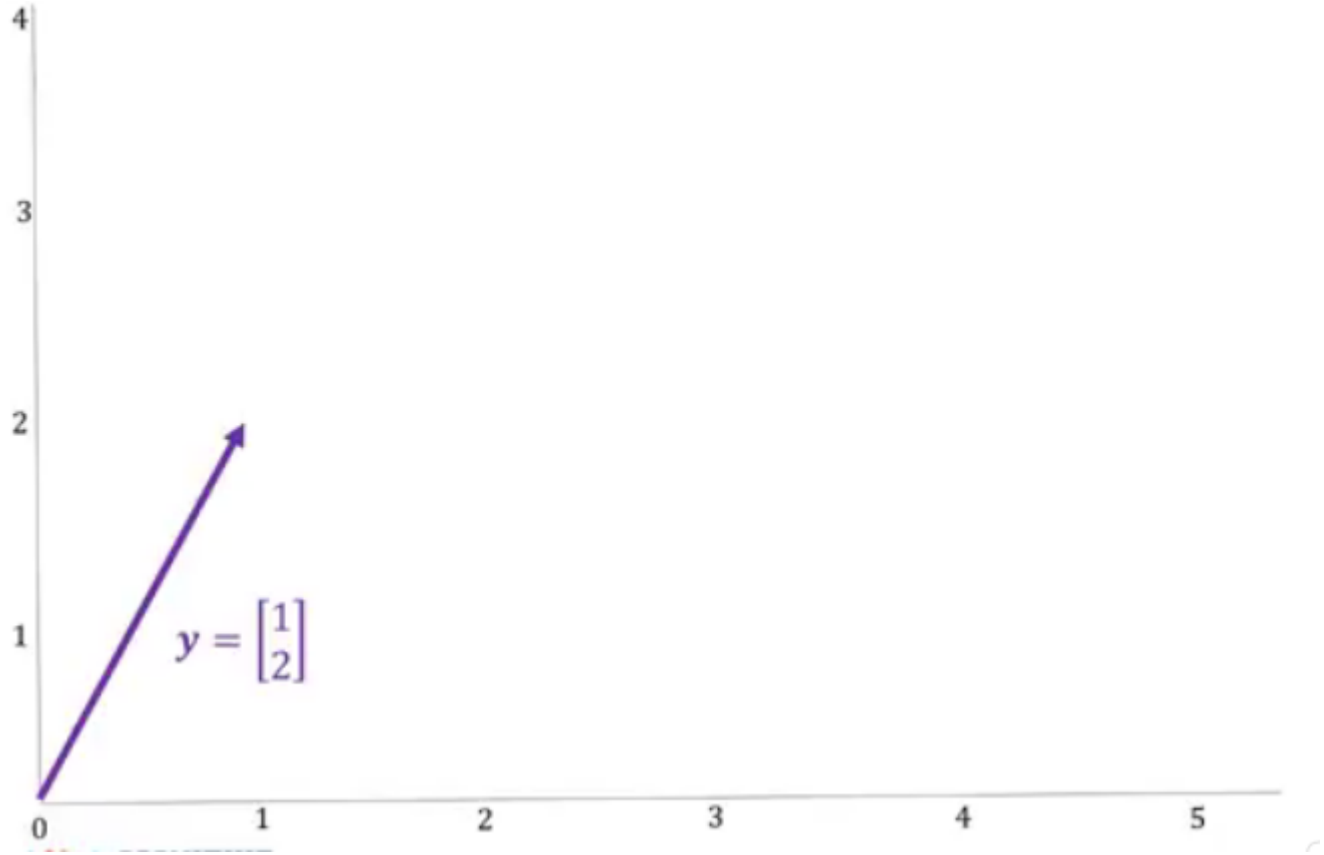
```
u=np.array([1,0])
v=np.array([0,1])

z=u-v

z:array([1,-1])
```

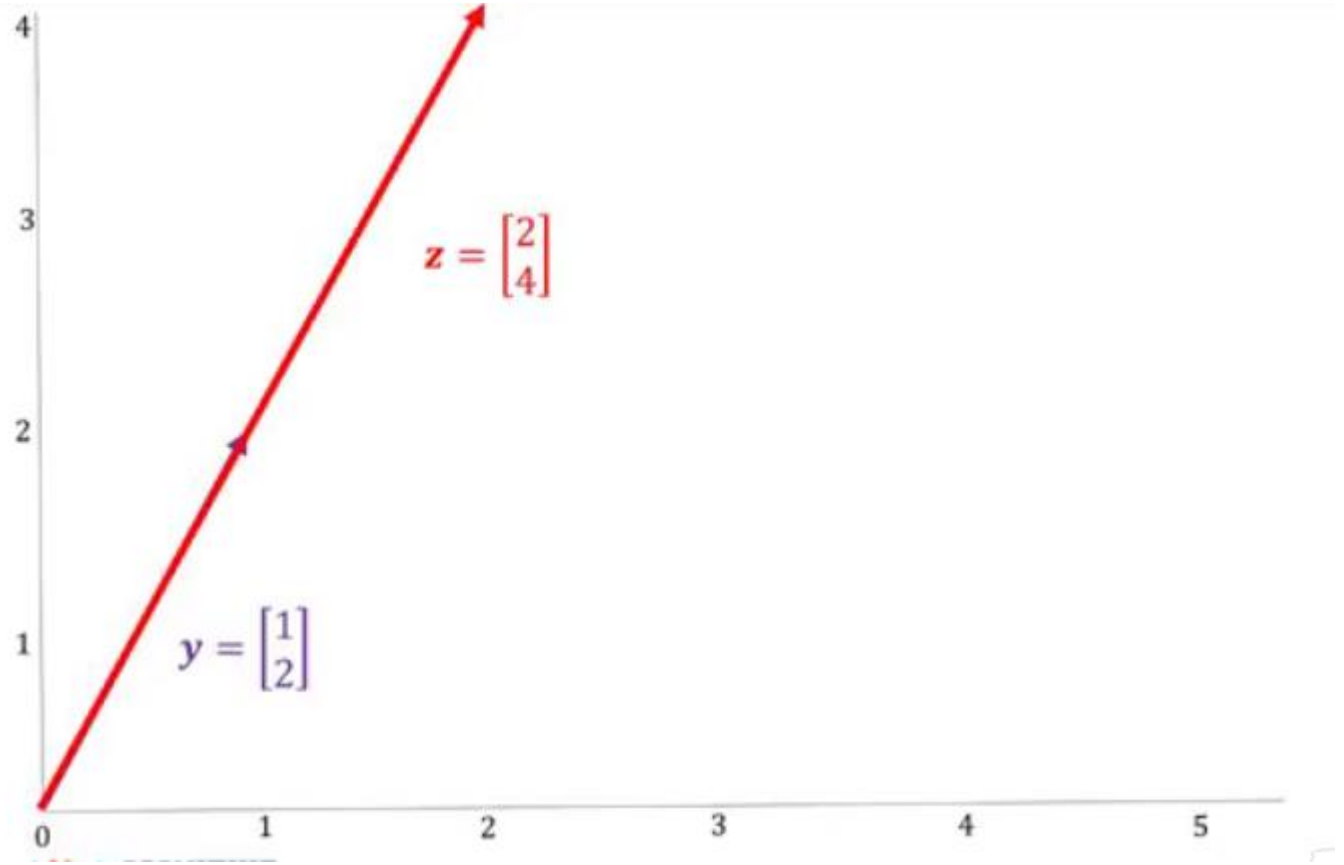
```
u=[1,0]
v=[0,1]
z=[ ]

for n, m in zip(u,v):

    z.append(n-m)
```

Array multiplication with scalar

$$y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$z = 2y = \begin{bmatrix} 2(1) \\ 2(2) \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \end{bmatrix}$$


4
3
2
1
0
1
2
3
4
5
$y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

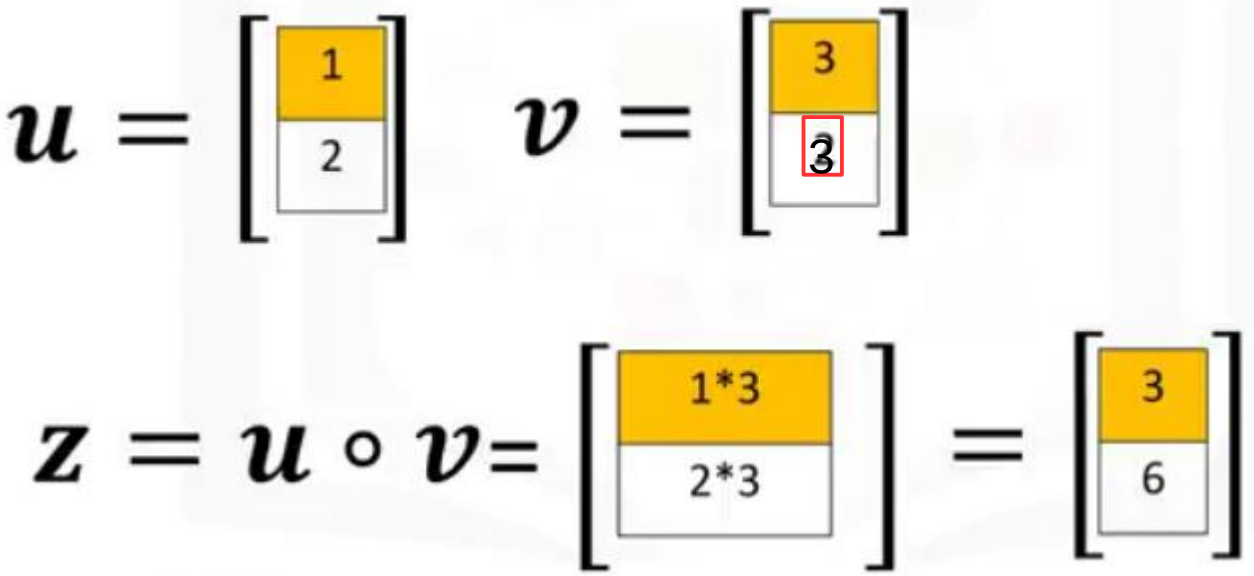

4
3
2
1
0
1
2
3
4
5
$z = \begin{bmatrix} 2 \\ 4 \end{bmatrix}$
$y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

```
y=np.array([1,2])

z=2*y
```

z:array([1,4])

```
y=[1 , 2]
z=[ ]

for n in y:

    z.append(2*n)
```

ضرب دو numpy array



```
u=np.array([1,2])
v=np.array([3,2])

z=u*v

z:array([3,  4])
```

```
u=[1,2]
v=[3,2]
z=[ ]

for n, m in zip(u,v):

    z.append(n*m)
```

ضرب نقطه ای

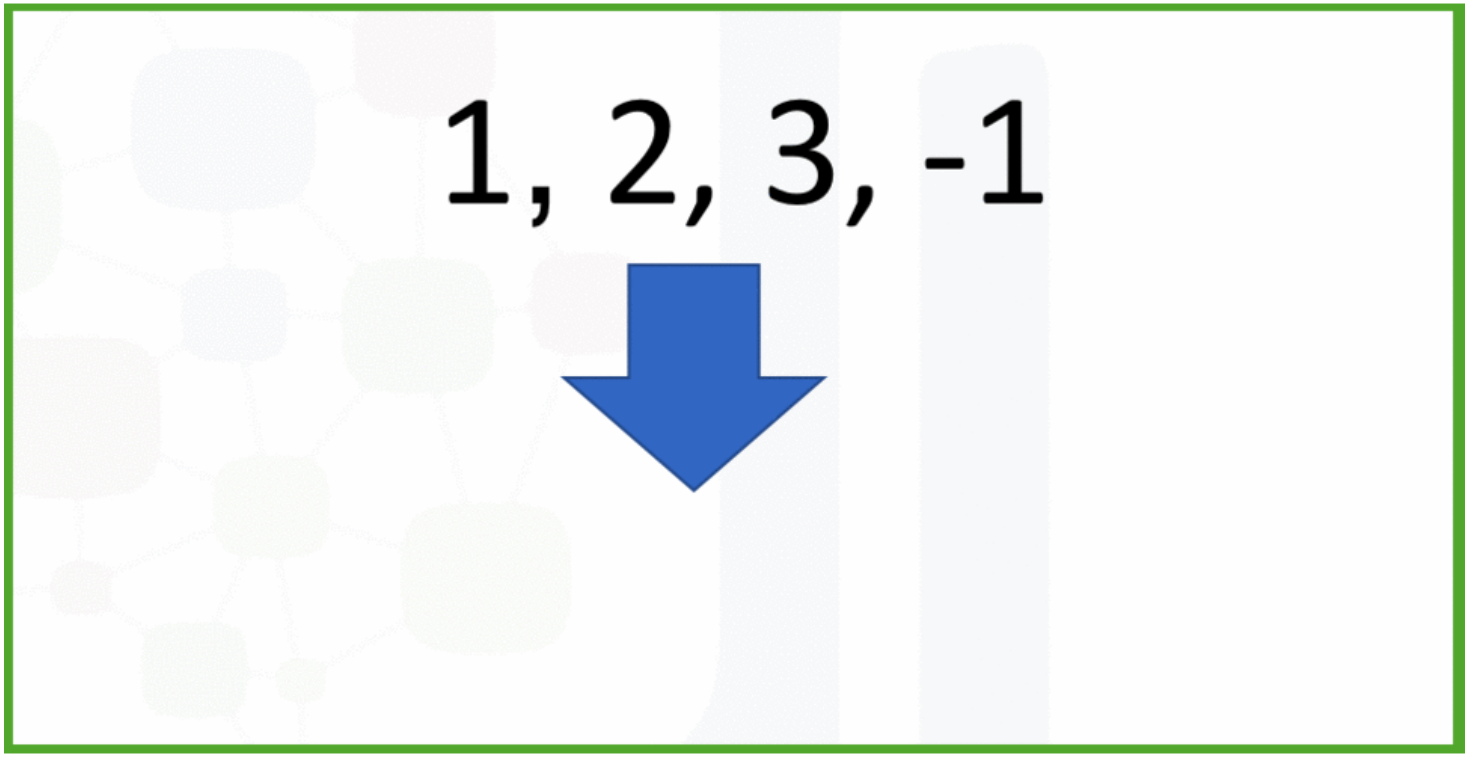
$$u = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \quad v = \begin{bmatrix} 3 \\ 1 \end{bmatrix}$$

$$u^T v = 1 \times 3 + 2 \times 1 = 5$$

```
u=np.array([1,2])
v=np.array([3,2])

result =np.dot(u,v)

result :5
```

اضافه کردن یک عدد ثابت به آرایه

```
u=np.array([1,2,3,-1])
z=u+1
z:array([2,3,4,0])
```



Universal functions

```
a=np.array([1,-1,1,-1])
mean_a=a.mean()
```

$$\frac{1}{4}\ (1-1+1-1)$$

max

```
b=np.array([1, -2,3,4,5 ])
max_b=b.max()
max_b:5
```

```
np.pi
x=np.array([ 0 , np.pi/2, np.pi ] )
y=np.sin(x)
y:array([ 0,1, 1.2e-16])
```

$$\pi$$

$$\boldsymbol{x} = [0, \frac{\pi}{2}, \pi]$$

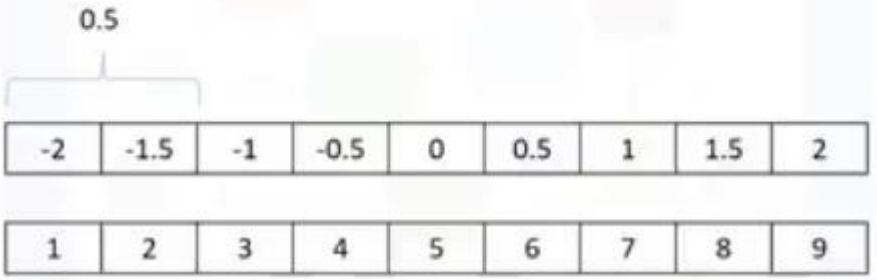
$$\boldsymbol{y} = [\sin(0), \sin(\frac{\pi}{2}), \sin(\pi)]$$

$$\boldsymbol{y} = [0,1,0]$$

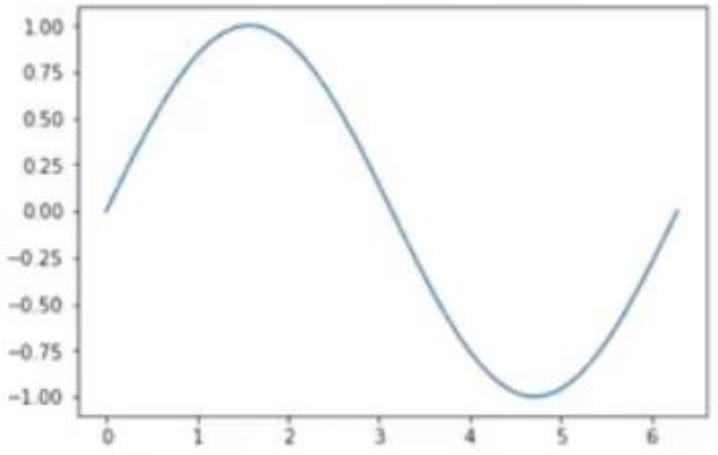
np.linspace

np.linspace(-2,2,num=5)

np.linspace(-2,2,num=9)



```
x=np.linspace( 0 , 2*np.pi,100)
y=np.sin(x)

import matplotlib.pyplot as plt
%matplotlib inline
plt.plot(x,y)
```



2nd part:
2D Arrays

$$a = [[11, 12, 13], [21, 22, 23], [31, 32, 33]]$$

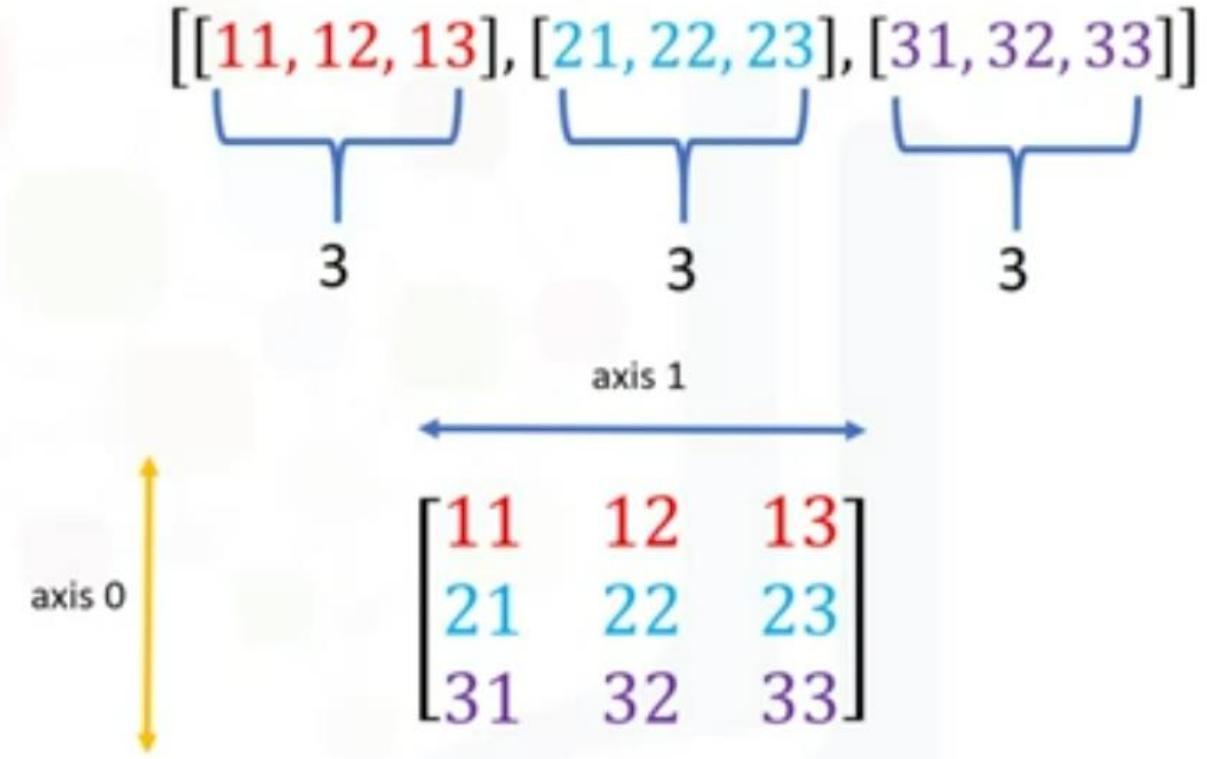
$$\mathrm{A} = \mathrm{np.array(a)}$$

$$\mathrm{A:}\begin{bmatrix} 11 & 12 & 13 \\ 21 & 22 & 23 \\ 31 & 32 & 33 \end{bmatrix}$$

A.ndim:2

A.shape: (3,3)

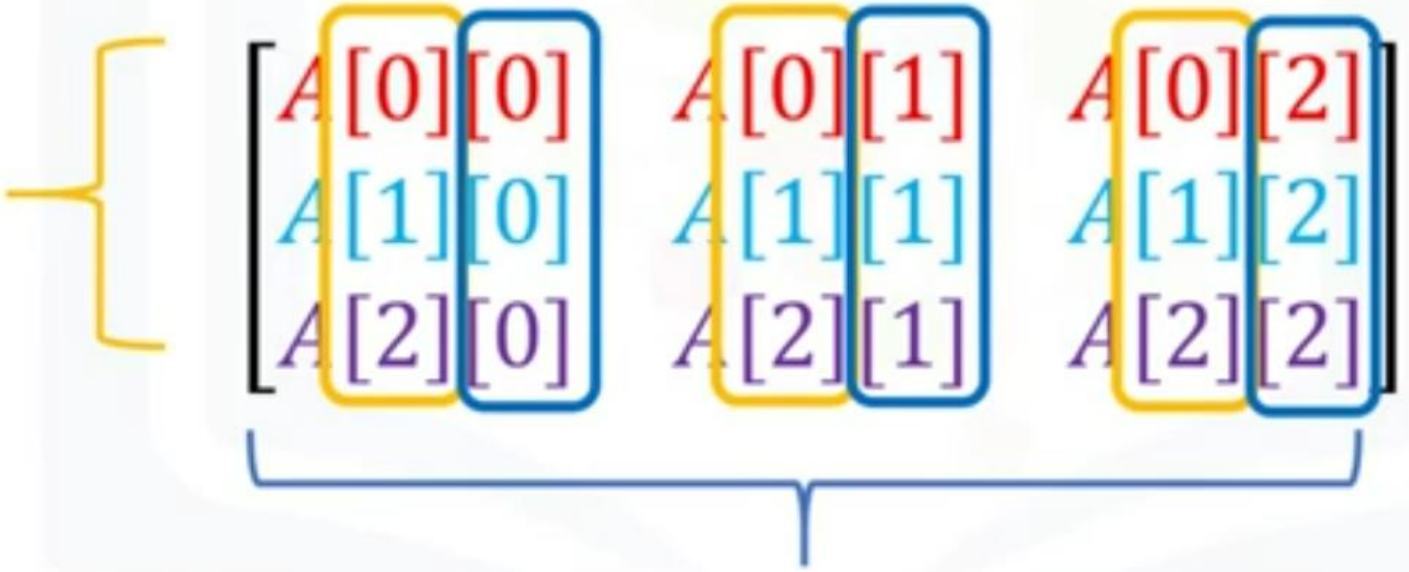
A.size



A: $[[A[0][0], A[0][1], A[0][2]], [A[1][0], A[1][1], A[1][2]][A[2][0], A[2][1], A[2][2]]]$

$$\begin{bmatrix} A[0][0] & A[0][1] & A[0][2] \\ A[1][0] & A[1][1] & A[1][2] \\ A[2][0] & A[2][1] & A[2][2] \end{bmatrix}$$

A: $[[A[0][0], A[0][1], A[0][2]], [A[1][0], A[1][1], A[1][2]][A[2][0], A[2][1], A[2][2]]]$



$$A: \left[[A[0,0], A[0,1], A[0,2]], [A[1,0], A[1,1], A[1,2]] [A[2,0], A[2,1], A\ [2,2]] \right]$$

$$\begin{bmatrix} A[0,0] & A[0,1] & A\ [0,2] \\ A[1,0] & A[1,1] & A[1,2] \\ A[2,0] & A[2,1] & A[2,2] \end{bmatrix}$$

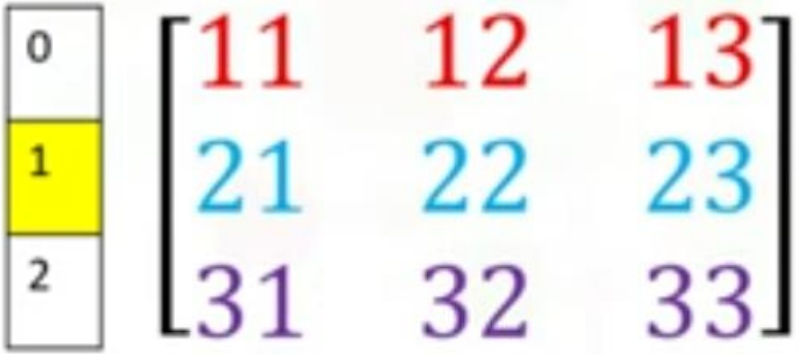
$$A = [[11, 12, 13], [21, 22, 23], [31, 32, 33]]$$

A[1][2]

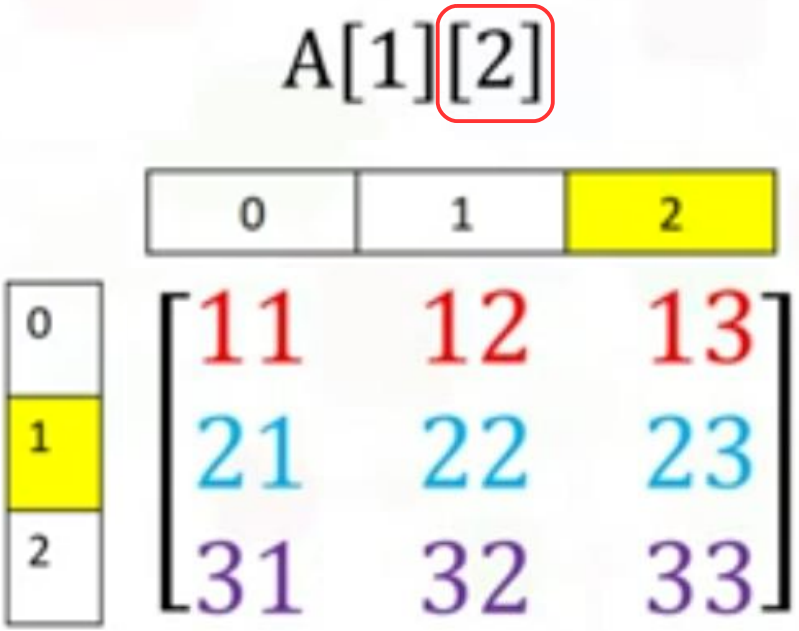
$$\begin{bmatrix} 11 & 12 & 13 \\ 21 & 22 & 23 \\ 31 & 32 & 33 \end{bmatrix}$$

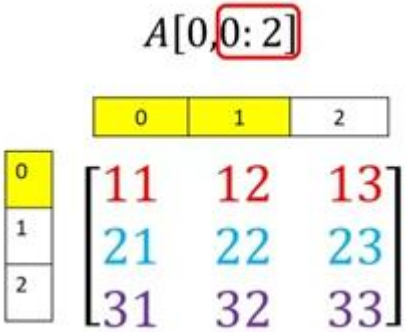
$$A = [[11, 12, 13], [21, 22, 23], [31, 32, 33]]$$

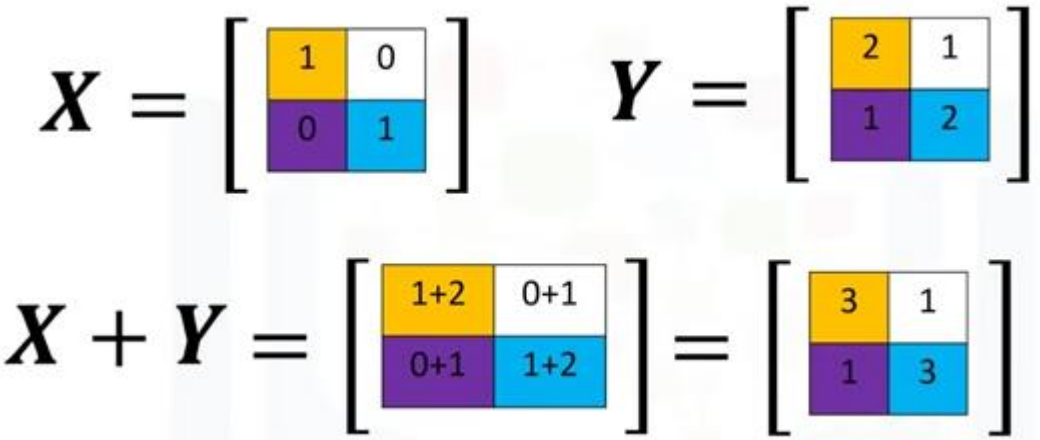
A[1][2]



$$A = [[11, 12, 13], [21, 22, 23], [31, 32, 33]]$$




A[0,0:2]
0
1
2
0
1
2
11
12
13
21
22
23
31
32
33


X = [1 0 / 0 1]
Y = [2 1 / 1 2]
X + Y = [1+2 0+1 / 0+1 1+2] = [3 1 / 1 3]

```
X=np.array([[1,0],[0,1]])
Y=np.array([[2,1][1,2]])
Z=X+Y;
Z:array([[3,1],
         [1,3]])
```

$$X = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$Y = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

$$Z = X + Y$$

$$Z = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$$

```
Y=np.array([[2,1],[1,2]])

Z=2*Y;

Z:array([[4,2],
         [2,4]])
```

$$\boldsymbol{Y} = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

$$\boldsymbol{Z} = 2\boldsymbol{Y} = \begin{bmatrix} (2)2 & (2)1 \\ (2)1 & (2)2 \end{bmatrix}$$

$$\boldsymbol{Z} = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$$

$$X = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \qquad Y = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

$$X \circ Y = \begin{bmatrix} (1)2 & (0)1 \\ (0)1 & (1)2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

```
X=np.array([[1,0],[0,1]])
Y=np.array([[2,1][1,2]])
Z=X*Y;
Z:array([[2,0],
         [0,2]])
```

$$X = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$Y = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

$$Z = X \circ Y = \begin{bmatrix} (1)2 & (0)1 \\ (0)1 & (1)2 \end{bmatrix}$$

$$Z = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$A = \left[\begin{array}{ccc} 0 & 1 & 1 \\ 1 & 0 & 1 \end{array}\right]$$

$$B = \left[\begin{array}{cc} 1 & 1 \\ 1 & 1 \\ -1 & 1 \end{array}\right]$$

$$AB = \left[\begin{array}{cc} & \\ & \end{array}\right]$$

```
A=np.array([[0,1,1],[1,0,1]])

B=np.array([[1,1],[1,1],[-1,1]])

C=np.dot(A,B);

C:array([[0,0],
         [0,2]])
```