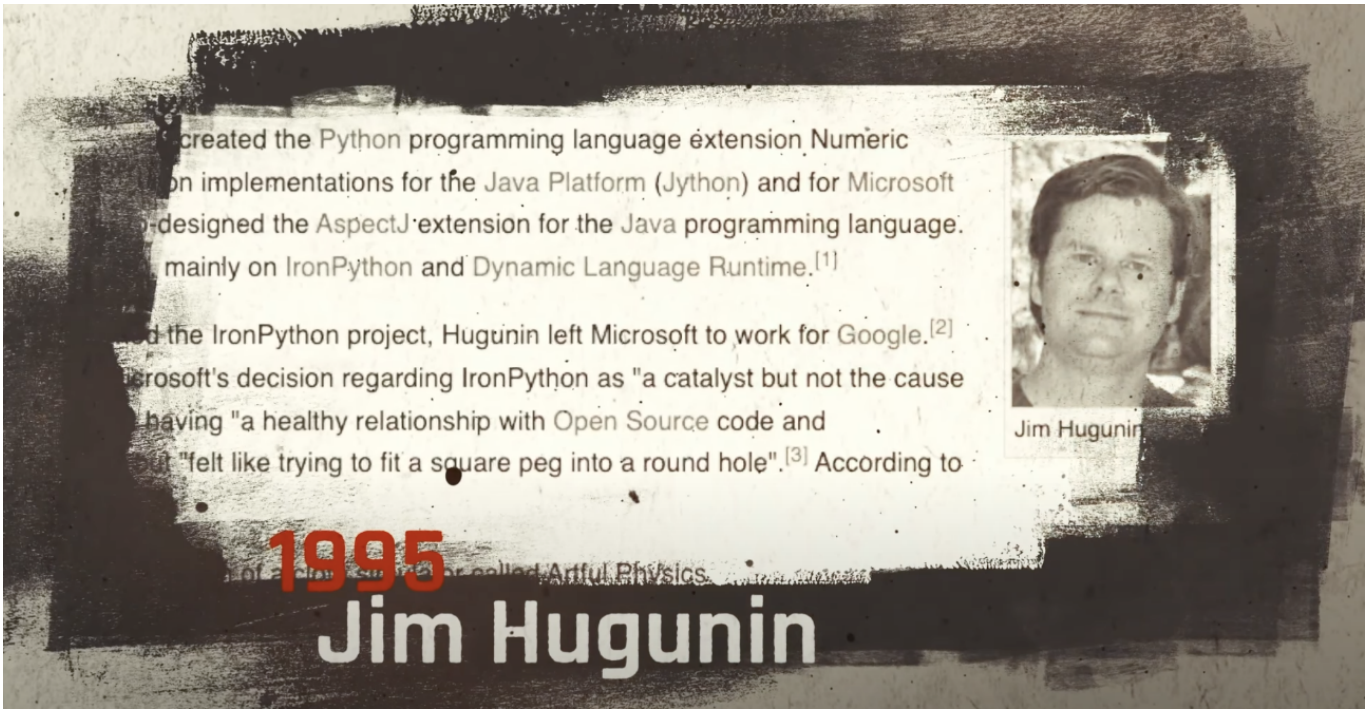
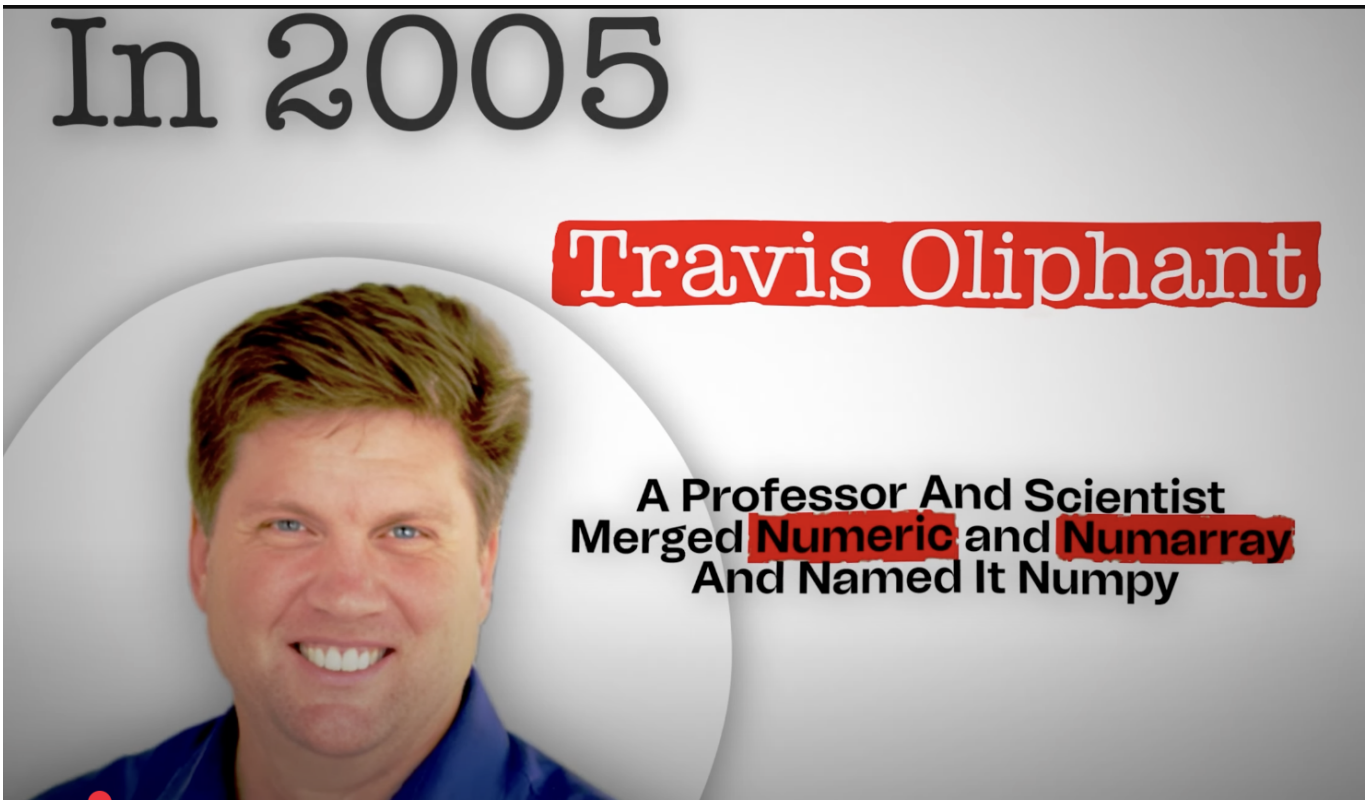
HISTORY OF NUMPY

Python always math এর জন্য ভালো কিন্তু পায়থন এর array support ছিল না এর জন্য ১৯৯৫ এ jims hugunin created numeric array . But its not good

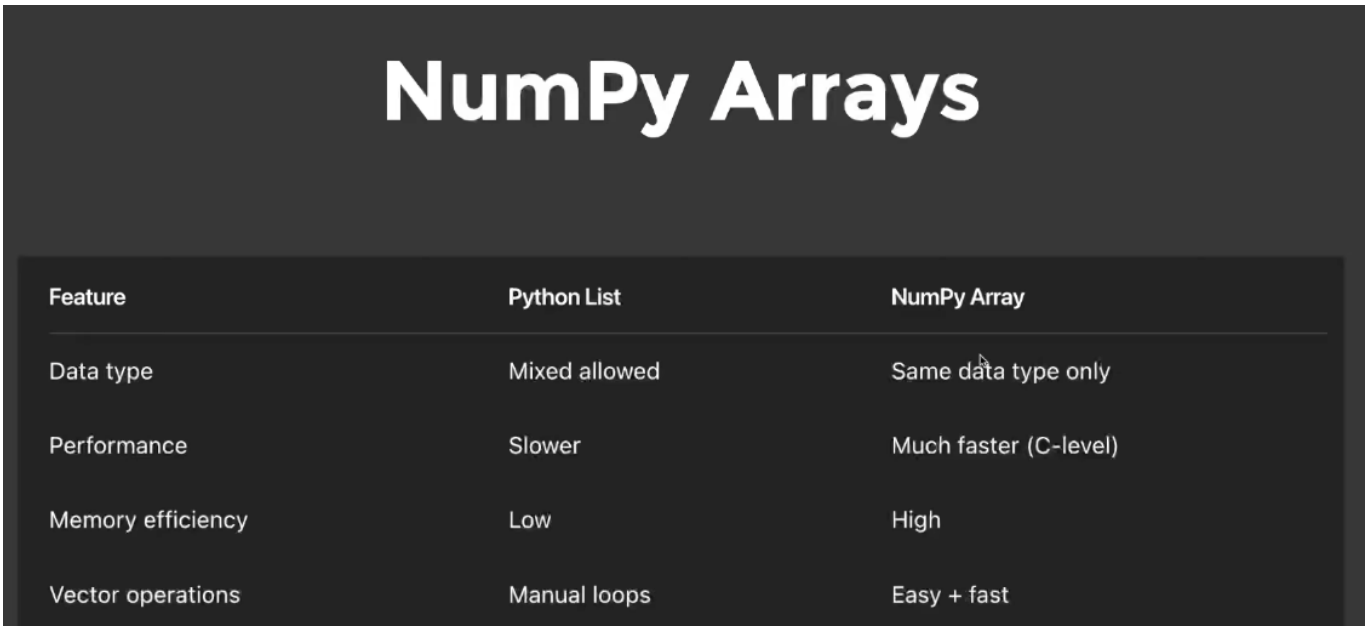


Then 2000 Numarray create করা হয় space telescopes science institute

Now still it's' not compatible but after that Travis oliphant Numeric and Numarray library combine করে Numpy create করে । Its' created by c programming and then its connected with python now its 50 times faster than list .



Difference Between List & Array

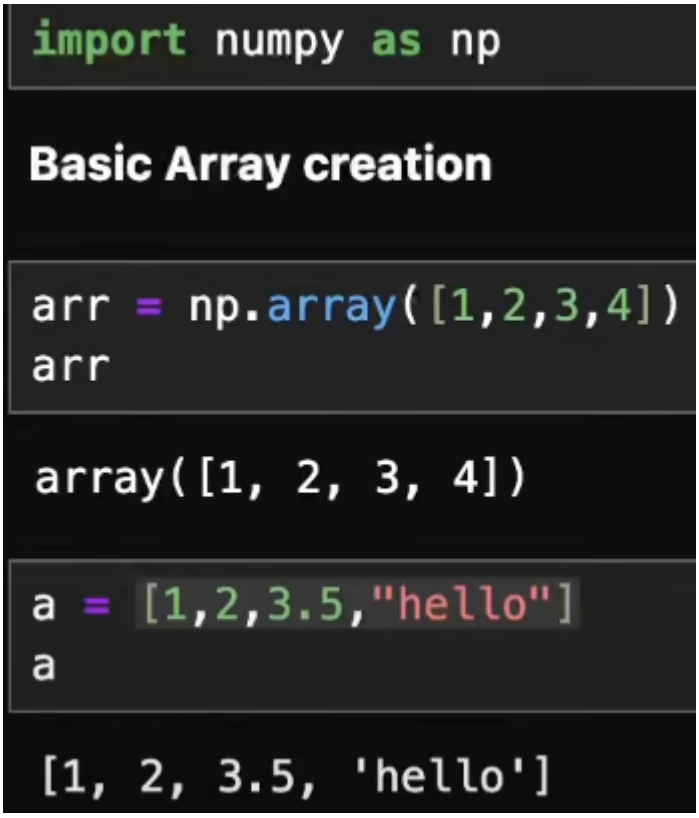


List এর মধ্যে আমরা একইসাথে অনেক ধরনের data type element রাখতে পারি কিন্তু Numpy array তে আমরা শুধু এক্টাইএপের element রাখতে পারি ।
Slower because python interpreted language আর numpy created by c

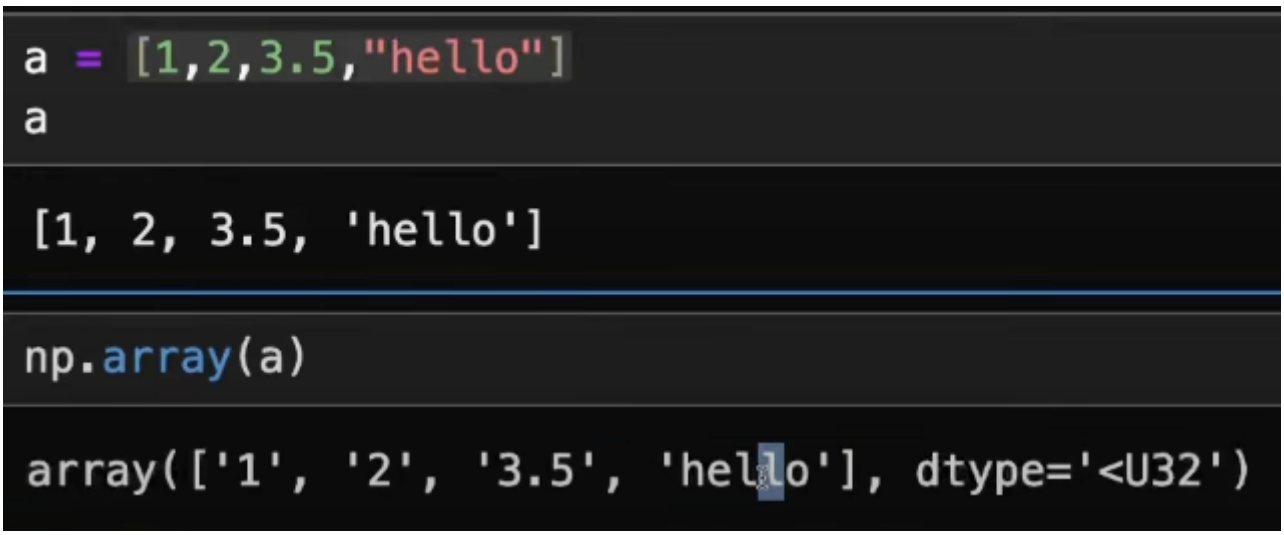
Numpy Start

Basic Array Creation

Import numpy as np np.array([]) তে একটা লিস্ট provides করে দিব এখানে এই লিস্ট কে array তে কনভার্ট করে দেয় ।



আমরা যদি একটা list এ string রেখে সেইটা array এর মধ্যে রাখি তাহলে array সেগুলোকে একটা Data type এ convert করে দিবে । যেমন এখানে সবগুলো কে string এ convert করে দিয়েছে ।



```
a = [1,2,3.5]
a
```

```
[1, 2, 3.5]
```

```
np.array(a)
```

```
array([1. , 2. , 3.5])
```

যেমন এখানে float value তে convert করে দিয়েছে ।

Vector And Matrix

Vector — One dimetional List Matrix — Multidimensional(2-ডি) (list multidimensional support ঈ করে না) Two dimensional এর উপরে যেগুলো সেগুলোকে বলা হয় tensar (3d , 4d, 5d) Here two dimensional list it's looking like a normal list but when we convert a list into array it's looking like a vector .

```
l = [[1,2,3],[4,5,6],[7,8,9]]
l
```

```
[[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

```
np.array(l)
```

```
array([[1, 2, 3],
       [4, 5, 6],
       [7, 8, 9]])
```

ARRAY GENERATION FUNCTION

If we generate array using arrange function np.arrange(1,11) — এখানে ১ থেকে ১০ পর্যন্ত array create হয়ে যাবে ।

এখানে arrange function এ ১ বাড়িয়ে দিতে হবে লাস্টের টার জন্য । যদি ১১ পর্যন্ত output চাই তাহলে ১২ ।

```
np.arange(1,11)
```

```
array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
```

Np.arange(1,11,2) step - 2 ঘর পর পর আসবে

```
arr = np.arange(1,11,2)
arr
```

```
array([1, 3, 5, 7, 9])
```

zeros(6) function .

```
arr = np.zeros(6)
arr
```

```
array([0., 0., 0., 0., 0., 0.])
```

It’s generated 4 rows & 8 columns .

```
arr = np.zeros((4,8))
arr
```

```
array([[0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0.]])
```

ones(6) — function

```
arr = np.ones(6)
arr
```

```
array([1., 1., 1., 1., 1., 1.])
```

```
arr = np.ones((6,6))
arr
```

```
array([[1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1.]])
```

If we want to generate default value not zeros or ones . Then we use full function np.full((shape) , value) ;

```
import numpy as np
filled_Array = np.full((2,2),7)
print(filled_Array)
```

```
oduction/creation/4.py"
[[7 7]
 [7 7]]
```

IDENTITY MATRIX np.eye() - it's a square matrix and ones in the diagonal .

```
identity_matrix = np.eye(4)
print(identity_matrix)
```

Output will be like that —>

```
[[1. 0. 0.]
 [0. 1. 0.]
 [0. 0. 1.]]
```

linspace()

আমরা যদি একটা function এ কাজ না জেনে থাকি তাহলে shift + tab দিবো তাহলে তা দেখতে পারবো কি করে এই ফাংশন । np.linspace(1,5,2) 1 থেকে ৫ পর্যন্ত প্রিন্ট করবে ২ টা element কিন্তু তাদের মধ্যে দূরত্ব সমান থাকবে।

```
arr = np.linspace(1,5,2)
arr
```

```
array([1., 5.])
```

1 থেকে ৫ পর্যন্ত ৩ টা element প্রিন্ট করবে কিন্তু তাদের মধ্যে সমান space থাকবে।

```
arr = np.linspace(1,5,3)
arr
```

```
array([1., 3., 5.])
```

```
arr = np.linspace(1,5,10)
arr
```

```
array([1.        , 1.44444444, 1.88888889, 2.33333333, 2.77777778,
       3.22222222, 3.66666667, 4.11111111, 4.55555556, 5.        ])
```

Random Generation function

5 random elements.

```
np.random.rand(5)
```

```
array([0.5178548 , 0.09144116, 0.55729517, 0.78944859, 0.8888938 ])
```

```
np.random.rand(10)
```

```
array([0.58291532, 0.17054358, 0.13068718, 0.32660627, 0.33849008,
       0.27173774, 0.7335558 , 0.0878656 , 0.24567008, 0.95931161])
```

Its provide vector Random vector 1 থেকে ০ এর মধ্যে আসবে । Its a concept of normalisation Random vector -3 থেকে ৩ এর মধ্যে আসবে । Its concept of standardisation (np.random.randn(10) — its give 10 random element -3 theke 3

```
np.random.randn(10)
```

```
array([ 0.75630459, -1.89031619, -0.83065648,  1.34618169,  1.04965949,
        1.32698836,  0.09977396, -1.2585357 ,  2.33771857, -0.42447521])
```

আর যদি আমি যেকোনো ভ্যালু আনতে চাই তাহলে কিভাবে করবো তারজন্যে np.random.randint(10) এর মানে ০ এর থেকে ৬ এর মধ্যে যেকোনো একটা নাম্বার প্রিন্ট করব ।

```
np.random.randint(6)

0
```

এখানে ১০ থেকে ২০ এর মধ্যে ১০ টা random number generate করে দিবে ।

```
np.random.randint(10,20,10)

array([17, 13, 19, 16, 12, 13, 11, 18, 17, 13])
```

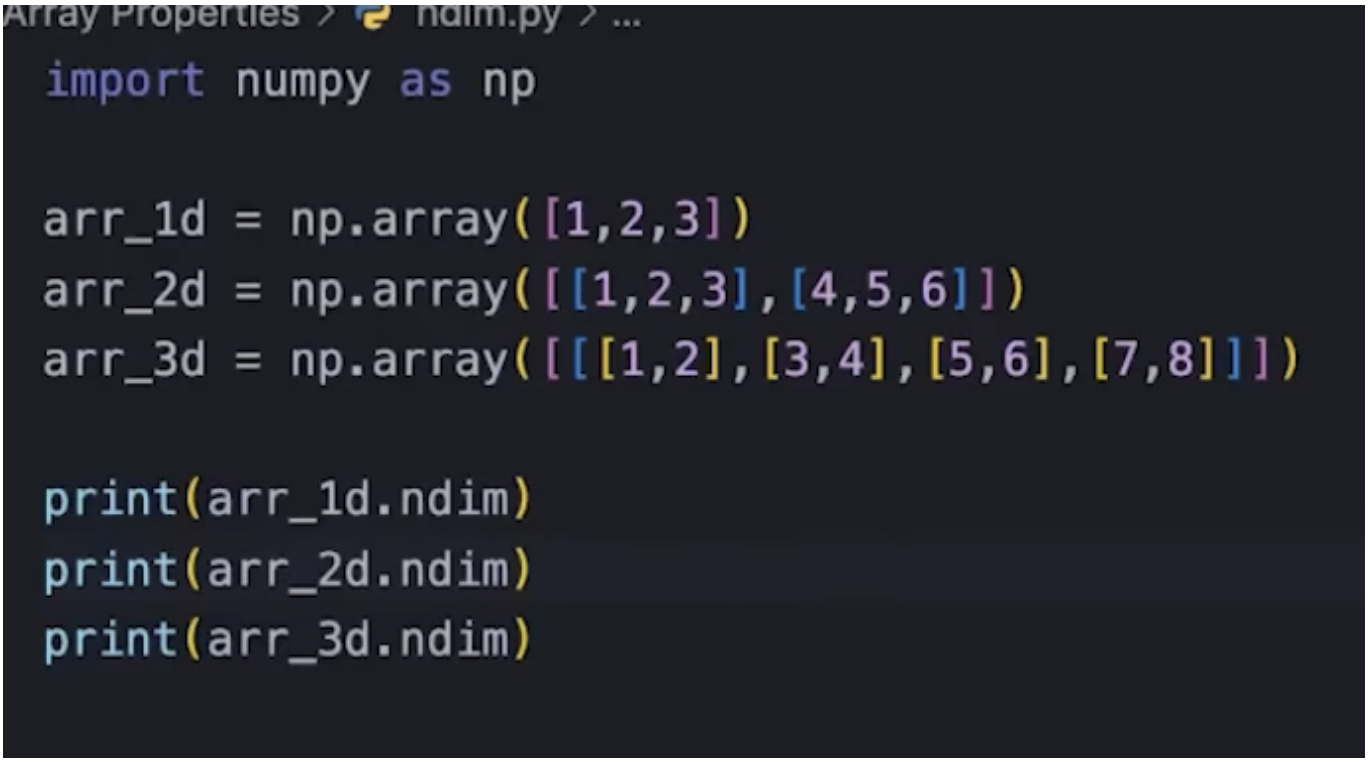
Attibute

Attribute কে cll করে না এর আগে () লাগানো হয় না । আর মেথড কে call করা হয় এর আগে () লাগানো হয় ।

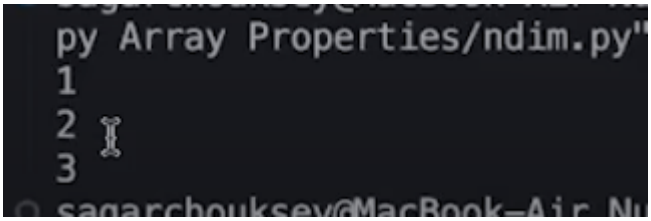
How to check Arrays shape , size , type ?

```
array([[1, 2, 3],
       [4, 5, 6],
       [7, 8, 9]])

arr.shape

(3, 3)

arr.size

9

arr.dtype

dtype('int64')
```

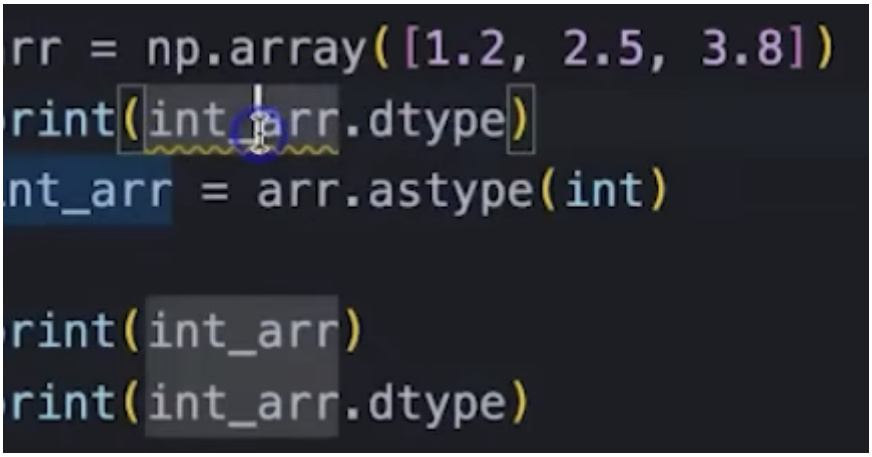
ndim — number of dimension . Array এর ডাইমেনশন জানা যায়।

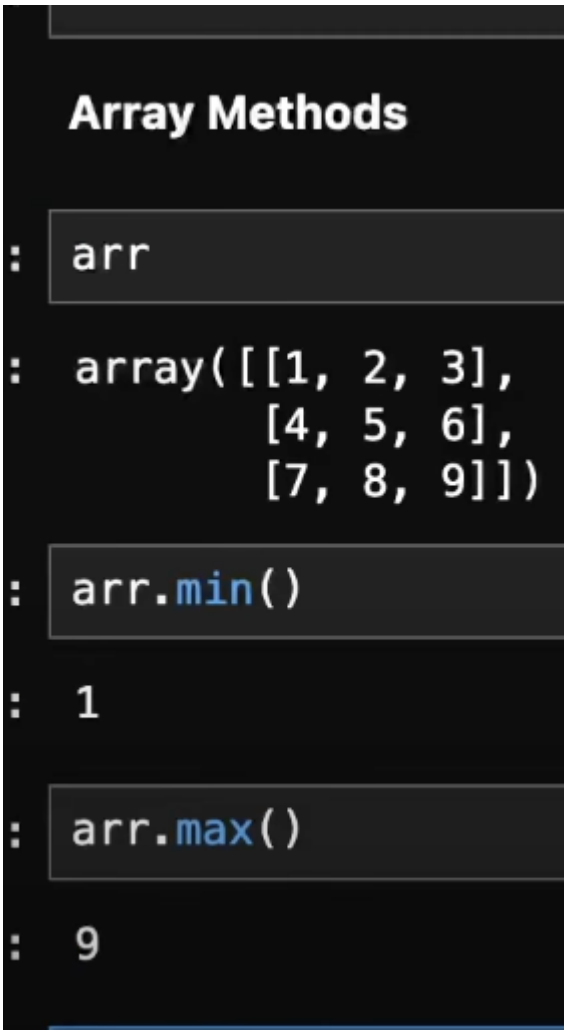


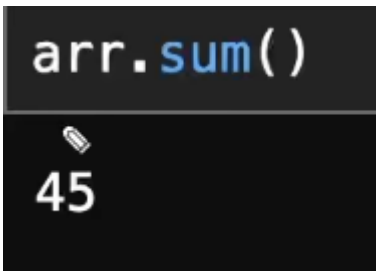
Output

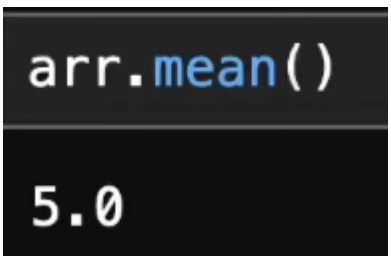


Datatype কে change করার জন্য.




Array Methods
: arr
: array([[1, 2, 3],
[4, 5, 6],
[7, 8, 9]])
: arr.min()
: 1
: arr.max()
: 9


arr.sum()
45


arr.mean()
5.0

```
arr.argmax()
```

```
8
```

```
arr.argmin()
```

```
0
```

arr.argmax() —> maximum element এর ইনডেক্স , arr.argmin() —> minimum element এর index দিবে ।

Column wise 0 axis and row wise 1-axis .

np.sum(arr, axis = 0) its provide column wise elements total sum np.sum(arr, axis = 1) it’s provide row wise elements total sum .

```
np.sum(arr,axis = 0)
```

```
array([12, 15, 18])
```

```
np.sum(arr,axis = 1)
```

```
array([ 6, 15, 24])
```

এইটা inbuild but np একটা দেয় আলাদা ভাবে ।

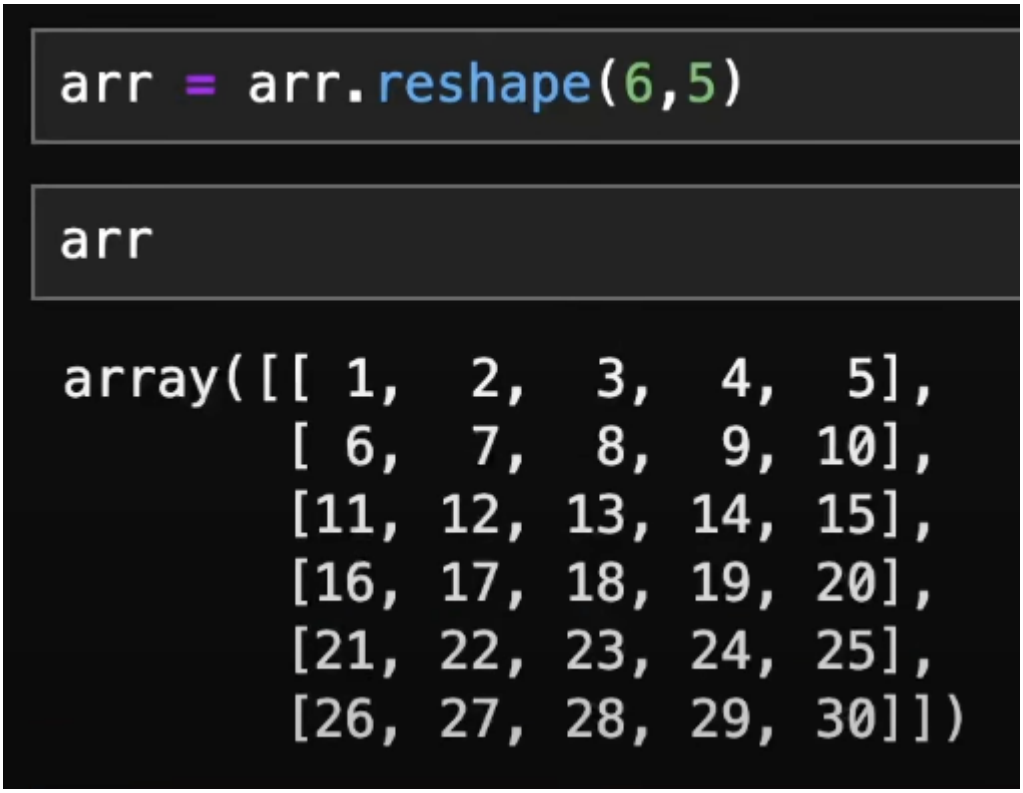
Reshaping & Resizing

Reshaping means I have already an array 1-d Vector . Now I want to convert its 2d vector . Reshape করতে হলে আমি যে array টা কে 1-d করবো সেটার মধ্যে সমান element থাকতে হবে আমি যে shpae এ কনভার্ট করবো । Here it is 25 element array now I want to 5*5 2d matrix .

```
arr = np.arange(1,31)
arr
```

```
array([ 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])
```

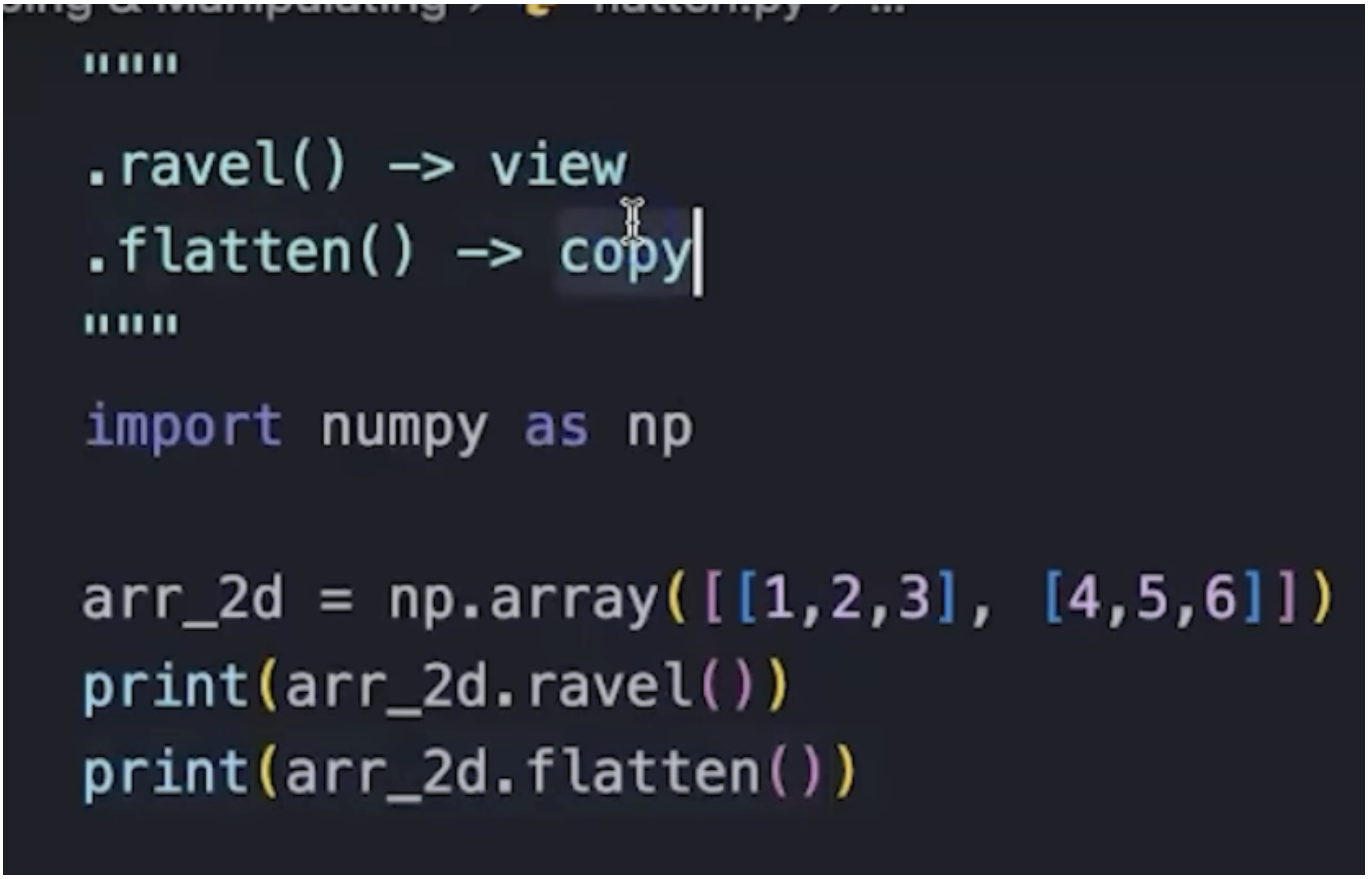
Arr এর মধ্যে save করতেছি এই টা হলো resizing আর reshape করেছি reshape function লিখে ।

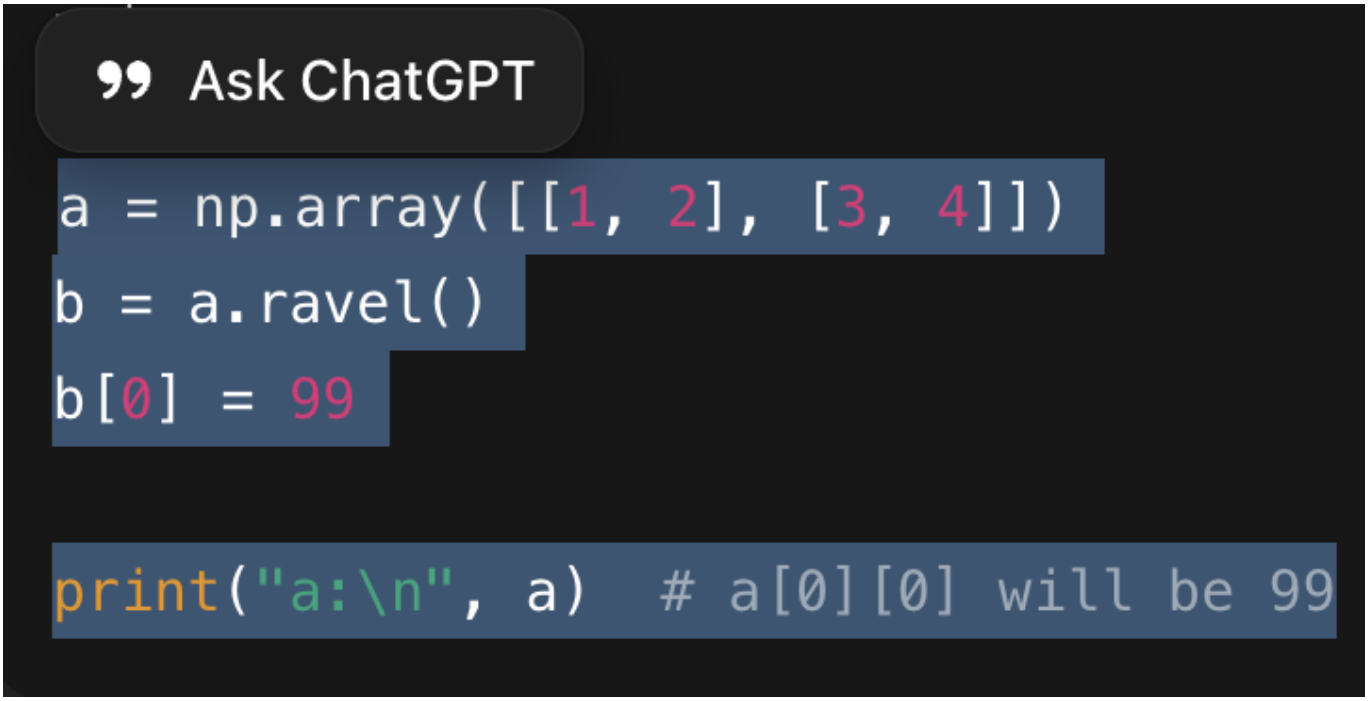


Ravel & flatten

আমরা যদি কোন 2-d array কে 1-d array তে কনভার্ট করি তাহলে flattering use করব। এইটা দুই ধরনের হয়- ravel , flatten Ravel — view (modification করলে main array তে modification হয়ে যায়।) Flatten — copy (modification

করলে main array তে modification হয় নাই।)





```
a = np.array([[1, 2], [3, 4]])
c = a.flatten()
c[0] = 99

print("a:\n", a)  # unchanged
print("c:\n", c)  # changed
```

ARRAY INDEXING AND SLICING

```
import numpy as np
```

```
NUMPY INDEXING AND SLICING OF VECTORS
```

```
arr = np.arange(11,21)
arr
```

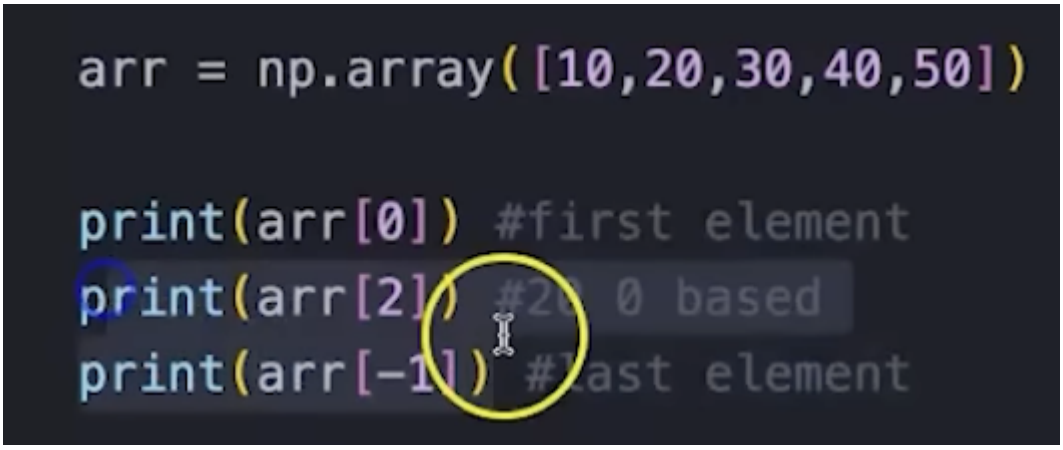
```
array([11, 12, 13, 14, 15, 16, 17, 18, 19, 20])
```

```
arr[9]
```

```
20
```

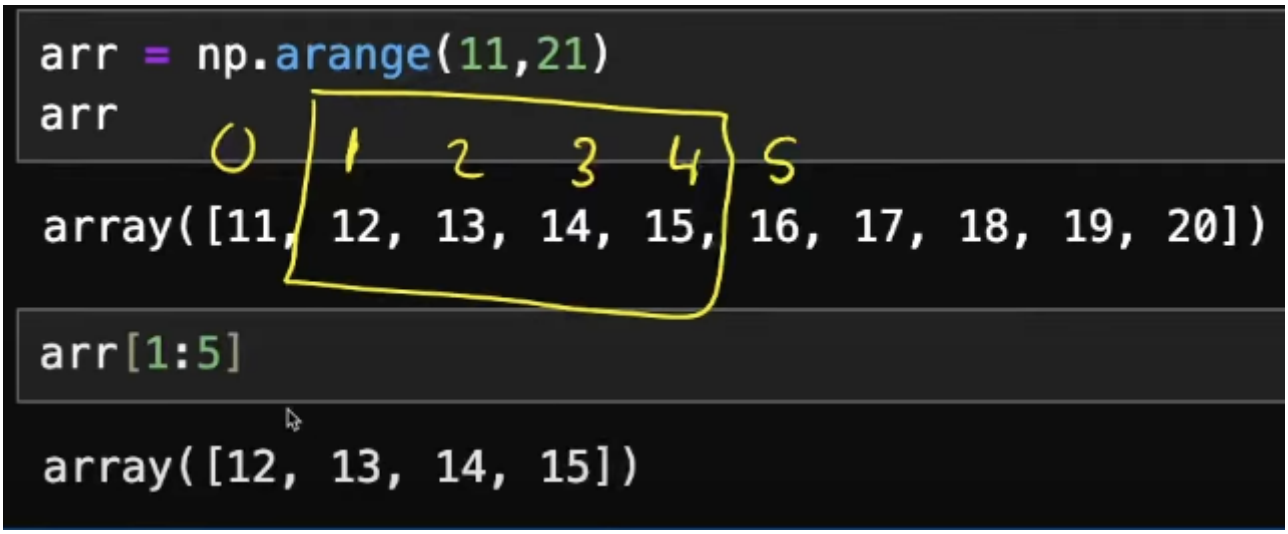
Array indexing এর মধ্যে দুইটা জিনিস থাকে একটা positive indexing & negative Indexing . Positive Indexing -> left to right value access করতে চাইলে। Negative Indexing —> Right To Left value Access করতে চাইলে। Last

element দেখতে চাইলে -1 দিতে হবে।

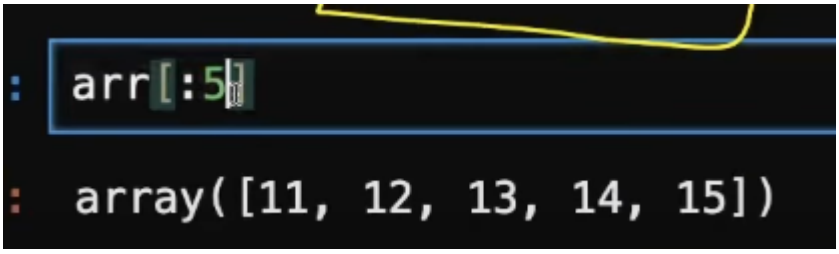


Array Slicing

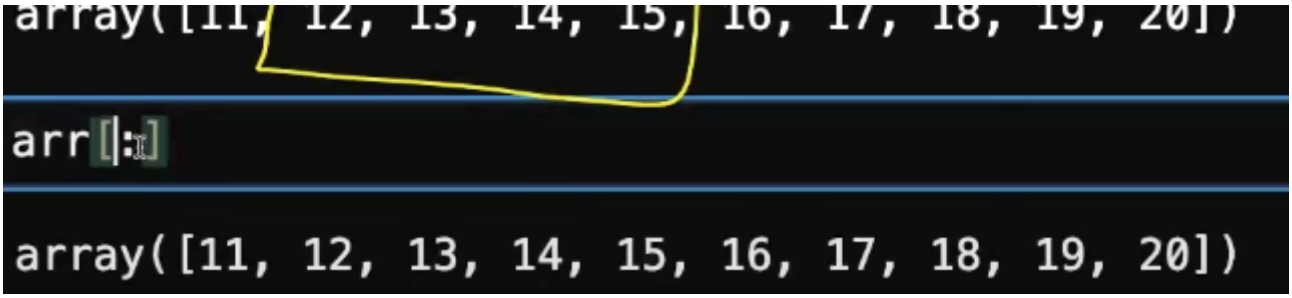
Slice করতে চাইলে আমরা প্রথম index দিবো তারপর শেষ ইনডেক্স এ last Wanted slice Index +1 দিবো arr[1:5] — 12 13 14 provide like that : Array [start : stop : step] — start index : stop Index +1 : step (কিছু না দিলে default value 1 হবে।) Negative step -1 দিলে reverse হবে।



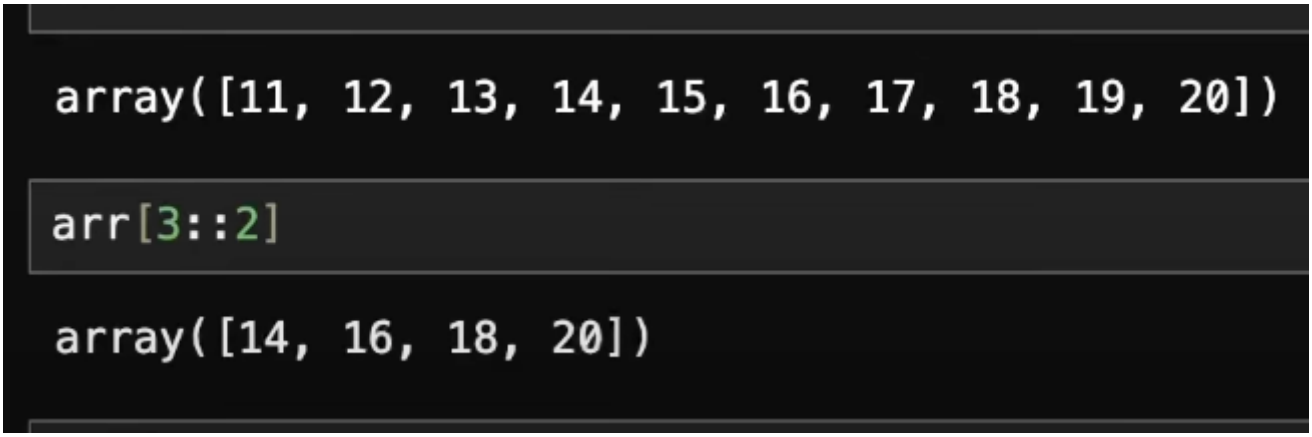
যদি starting index না দেই default প্রথম ইনডেক্স ০ ধরে নিবে ।



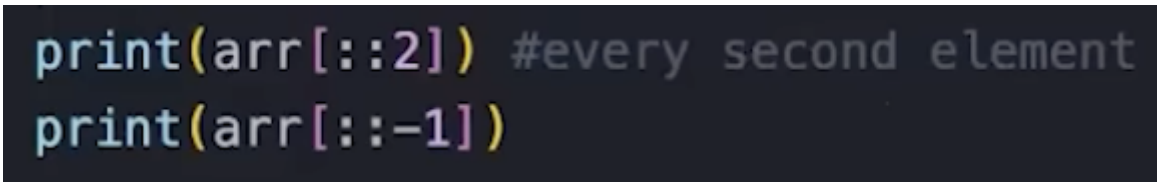
যদি লাস্ট এর ইনডেক্স ও না দেই তাহলে সব ভ্যালুই এসে পরবে । আর যদি last index না দেই তাহলে লাস্ট ইনডেক্স পর্যন্ত চলে যাবে ।



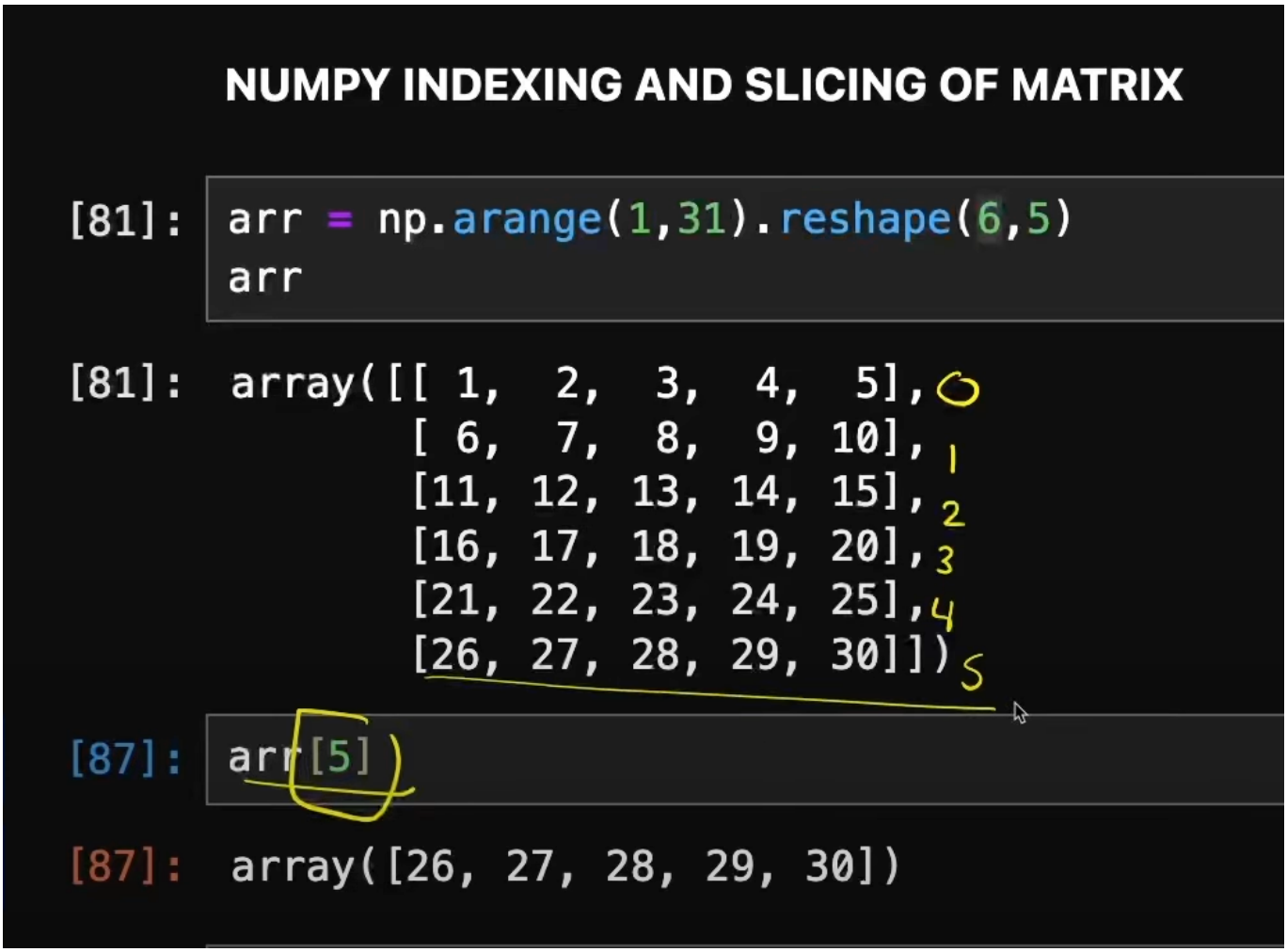
যদি ভ্যালু গুলো কয়েক ঘর পর পর পেতে চাই তাহলে ::want এভাবে দিবো ।

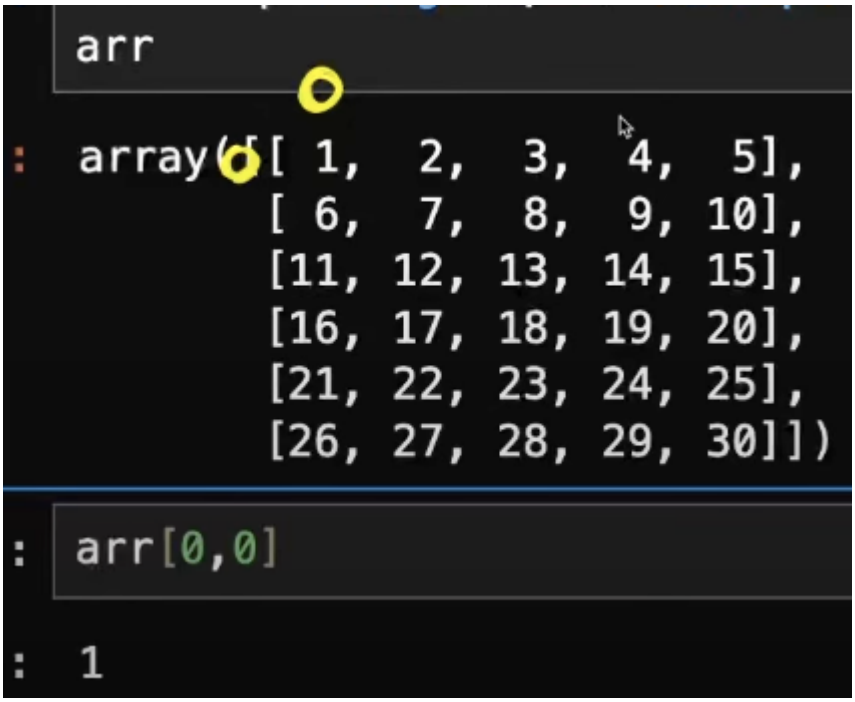


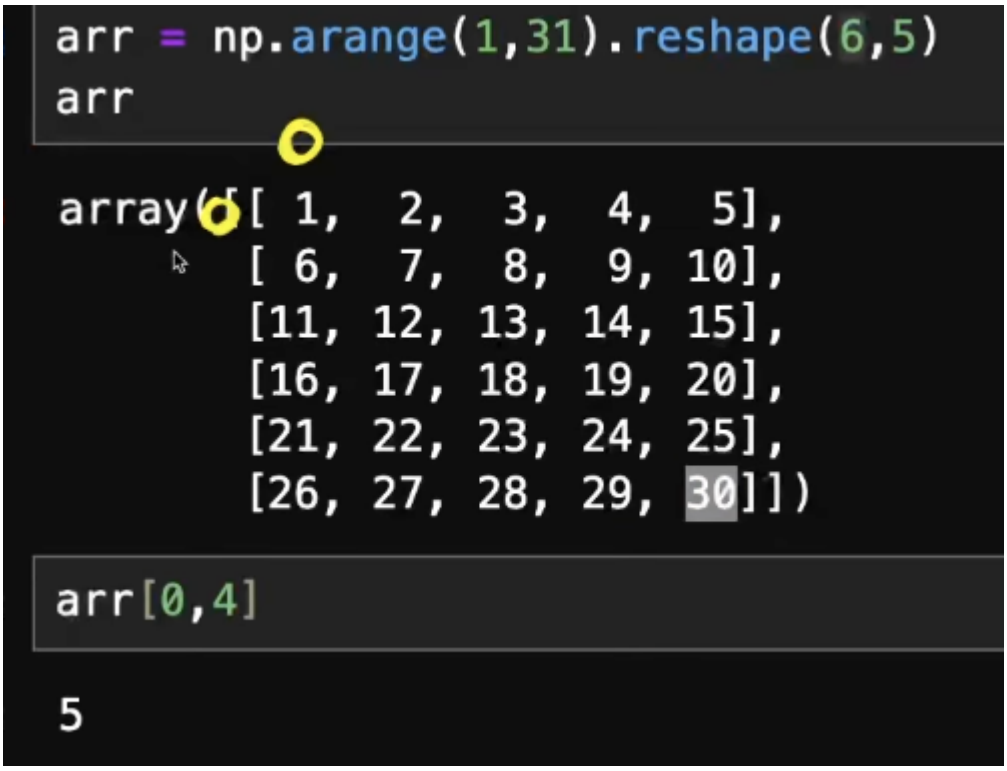
এই যে এখানে ২ ঘর পর পর আসবে ।



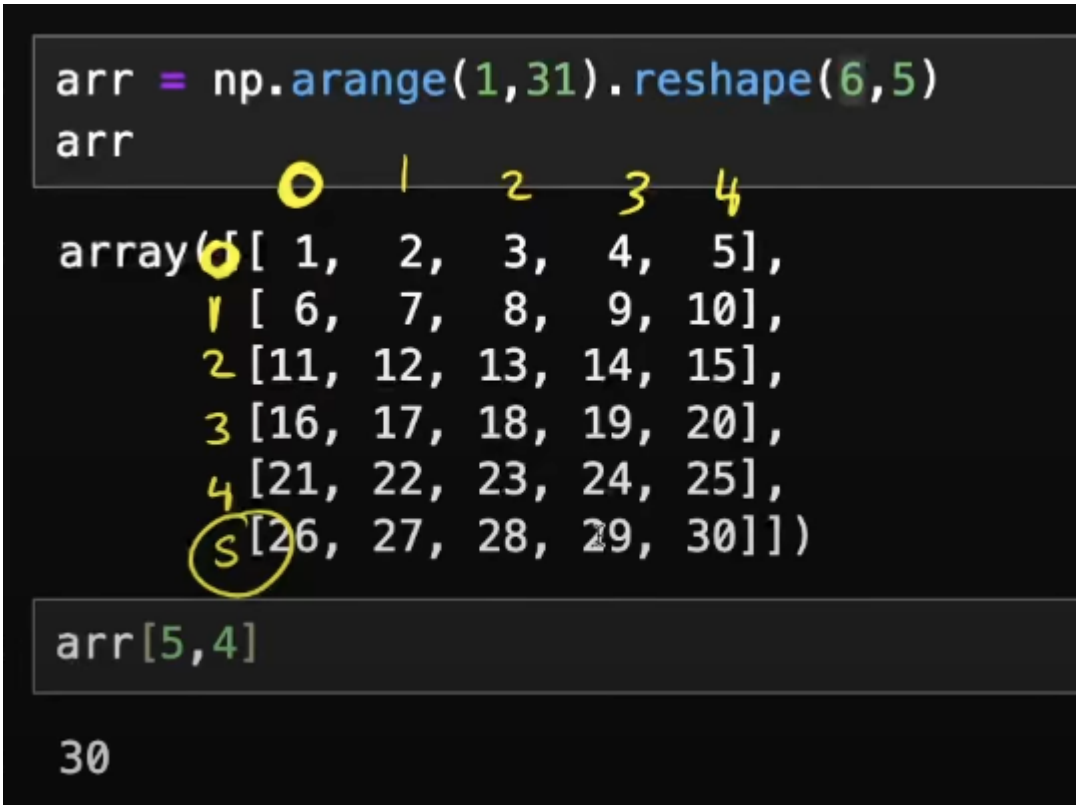
2-d vector এ আমরা যদি কোন একটা ইনডেক্স ভ্যালু দেই তাহলে রো সব টা আসবে । Index that will target rows .

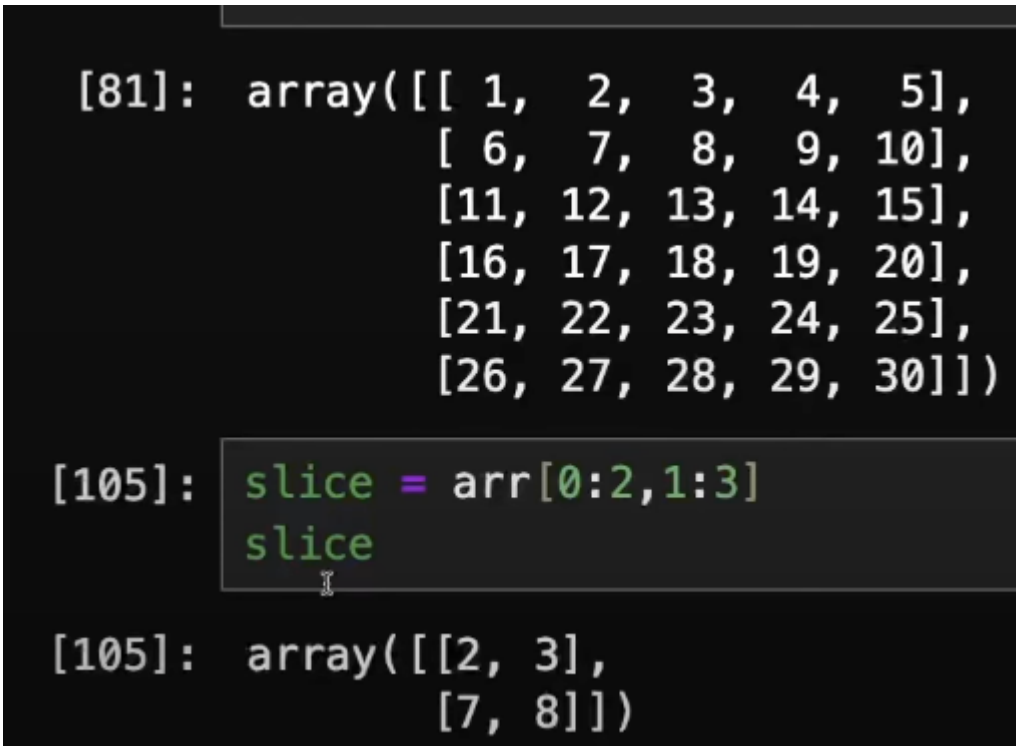

NUMPY INDEXING AND SLICING OF MATRIX
[81]: arr = np.arange(1,31).reshape(6,5)
arr
[81]: array([[1, 2, 3, 4, 5],
[6, 7, 8, 9, 10],
[11, 12, 13, 14, 15],
[16, 17, 18, 19, 20],
[21, 22, 23, 24, 25],
[26, 27, 28, 29, 30]])
0
1
2
3
4
5
[87]: arr[5]
[87]: array([26, 27, 28, 29, 30])


arr
array([[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]])
arr[0,0]
1

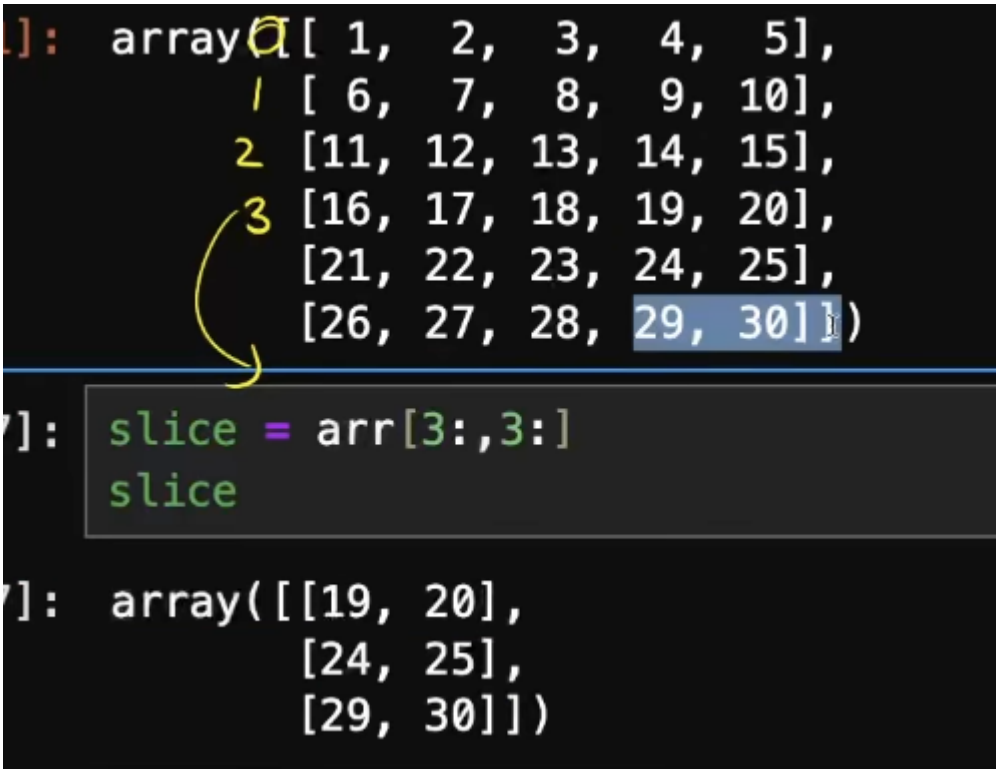


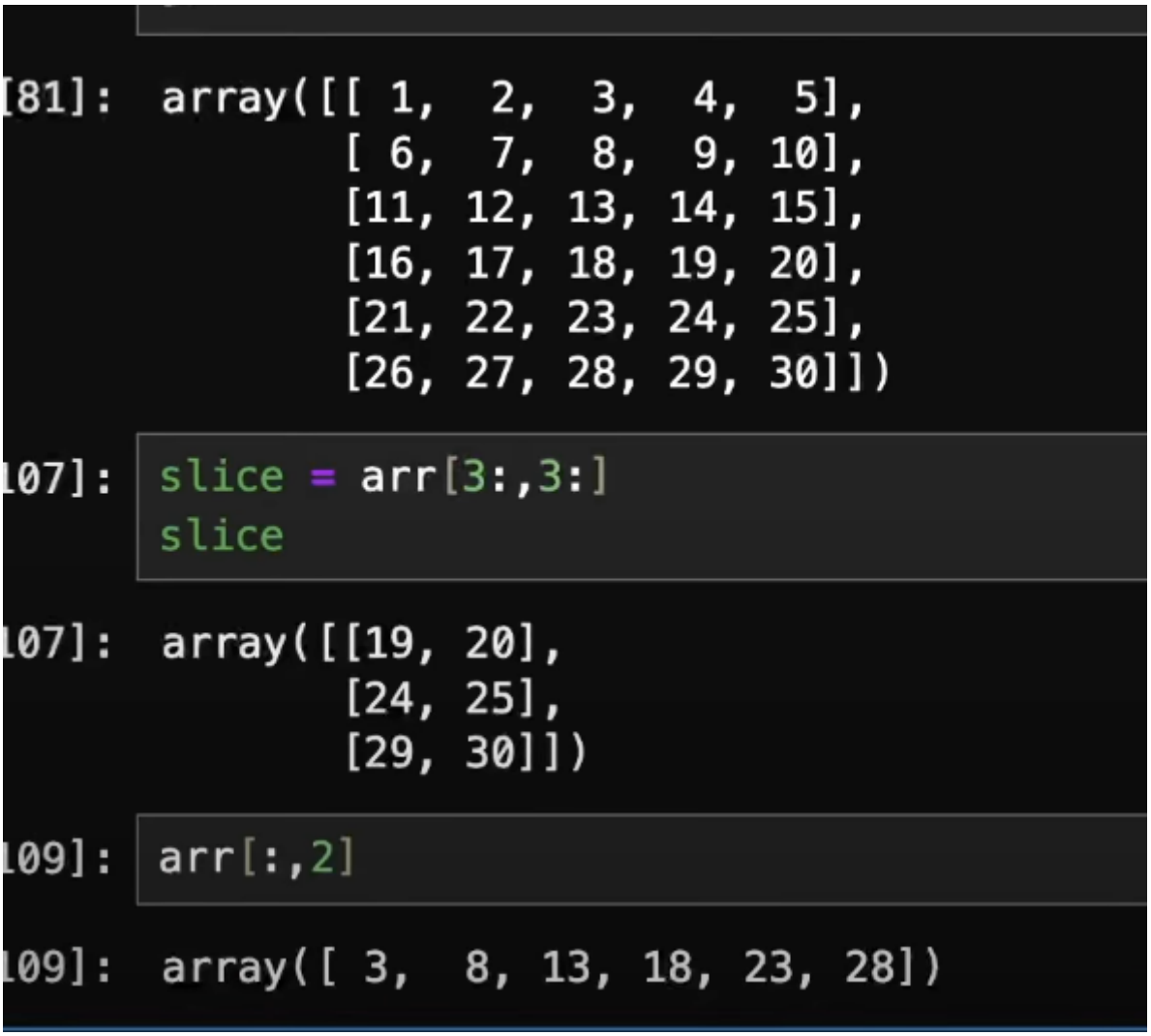
First targeting first row index then targeting col index if we find the value .





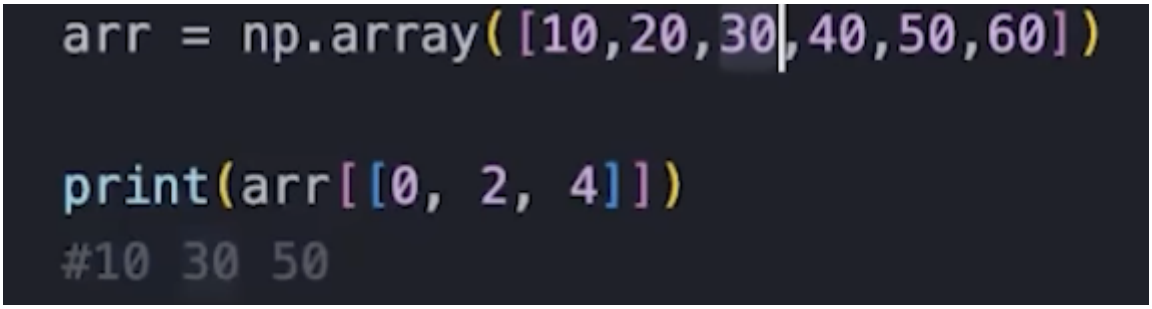
arr[3 : 6 , 3 : 5] it’s wrong if we want to slicing last index it right code will be like that arr[3 : , 3 :] ;





FANCY INDEXING

Fancy indexing হলো একসাথে কত গুলো ইনডেক্স নিতে চাইলে তখন এই টা ব্যবহার করব।



আর এখানে shallow copy হয়। আমার মেইন array তে পরিবর্তন হবে না যদি নতুন array তে কোনো modification করি।

Boolean Masking

```
arr = np.array([10,20,30,40,50,60])

print(arr[arr > 25])
```

এখানে আমরা কোনো লুপ চালিয়ে কন্ডিশন না দিয়ে সরাসরি একটা array এর থেকে ২৫ থেকে বড় যে ভ্যালু গুলো সেগুলো পেতে পারি।

ARRAY OPERATION

যখন আমরা array operation চালাই তখন আমরা ২ বা ২ ততোধিক array এর উপর চালাই ।

If we want to sum two array elements . দুইটা array এর সাইজ সমান হতে হবে । Addition & Substation & multiplication & division :

```
[141]: a1 = np.array([1,2,3,4,5])
       a2 = np.array([6,7,8,9,10])

[149]: a1 + a2

[149]: array([ 7,  9, 11, 13, 15])

[151]: a1 -a2

[151]: array([-5, -5, -5, -5, -5])

[153]: a1 * a2

[153]: array([ 6, 14, 24, 36, 50])

[155]: a1 / a2

[155]: array([0.16666667, 0.28571429, 0.375     , 0.44444444, 0.5       ])
```

Power

```
[159]: a1 ** a2

[159]: array([      1,     128,    6561,  262144, 9765625])
```

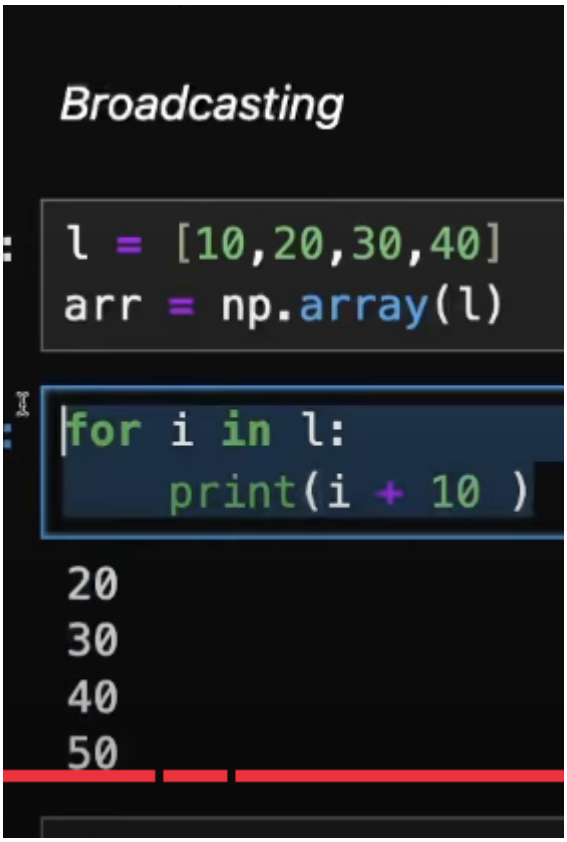
Broadcasting

How NUMPY handle array of Different shape .

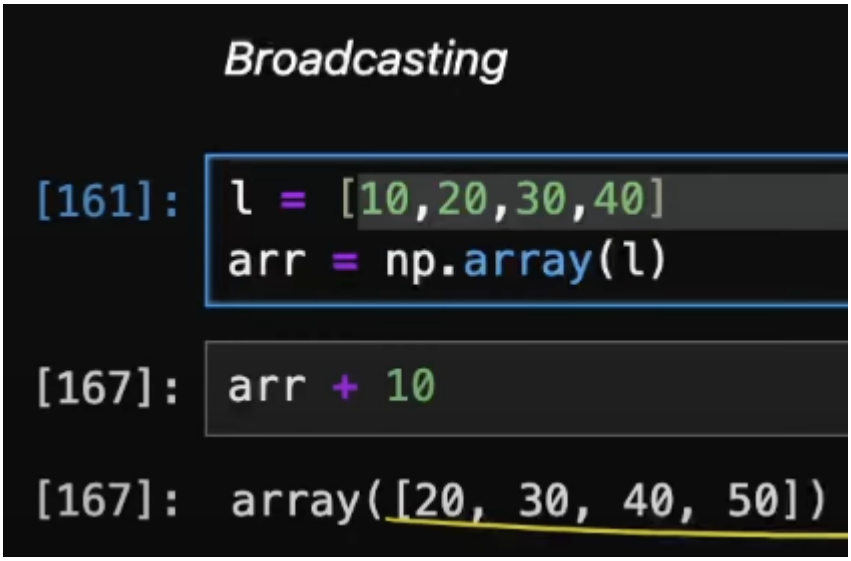
Broadcasting 3 rule :

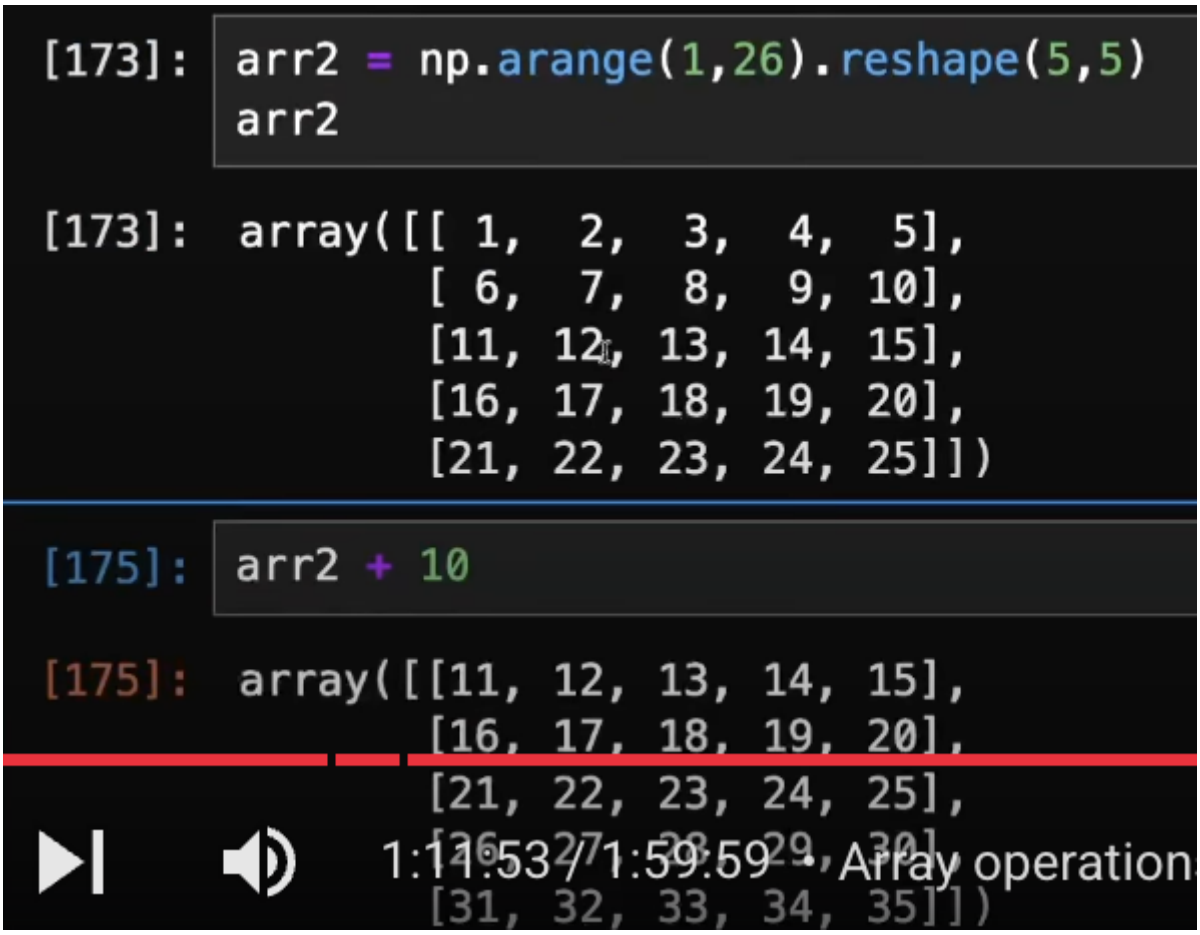
- 1. Matching Dimension ([1,2,5] + [3,4,5] = [4 , 6 , 10]
- 2. Expanding Single Element ([1,2,3] + 10 = [11 ,12 , 13]
- 3. Incompatible Shape(shape match না করলে numpy error দিয়ে দিবে[১,৩,৫]+[১,৩] error)

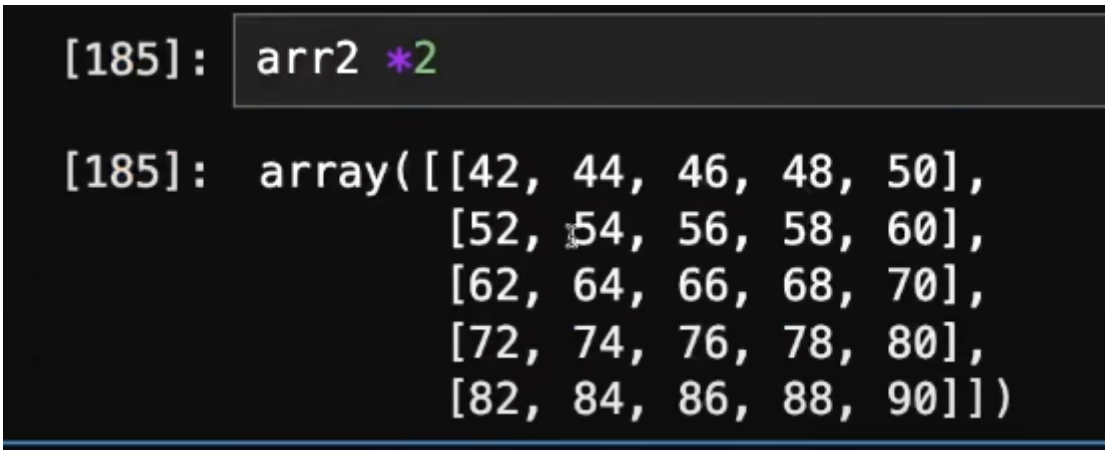
List এ প্রত্যেকটা element এর সাথে ১০ যোগ করতে চাইলে আমরা for loop চালাতে হতো ।

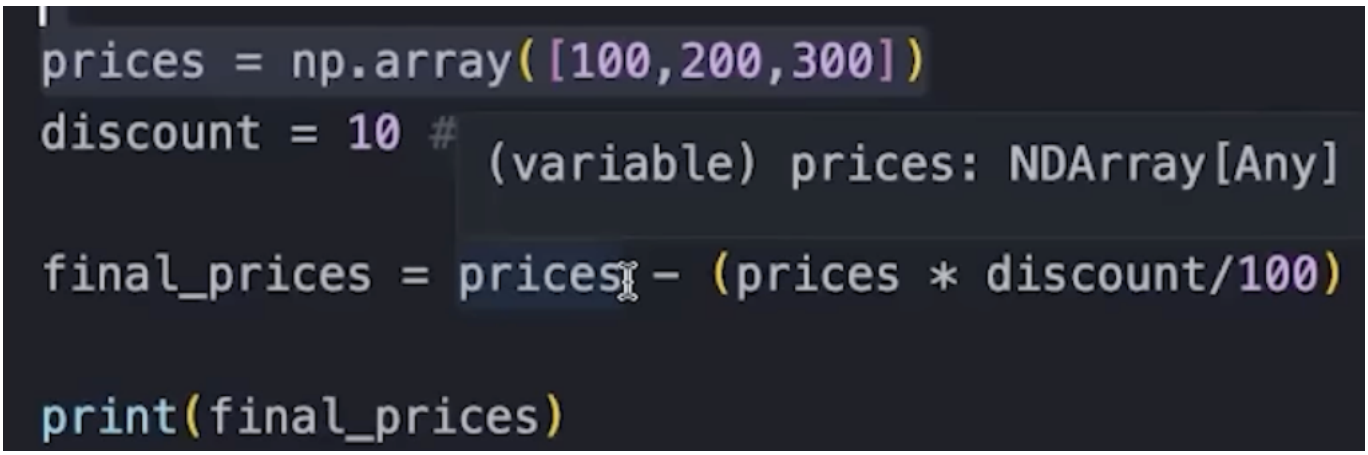


কিন্তু array তে ১০ সবগুলো array element এর সাথে যোগ করতে চাচ্ছি তাহলে array variable + 10 করলেই হবে ।




[173]: arr2 = np.arange(1,26).reshape(5,5)
arr2
[173]: array([[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]])
[175]: arr2 + 10
[175]: array([[11, 12, 13, 14, 15],
[16, 17, 18, 19, 20],
[21, 22, 23, 24, 25],
[31, 32, 33, 34, 35]])
1:11:53 / 1:59:59 • Array operation


[185]: arr2 *2
[185]: array([[42, 44, 46, 48, 50],
[52, 54, 56, 58, 60],
[62, 64, 66, 68, 70],
[72, 74, 76, 78, 80],
[82, 84, 86, 88, 90]])


prices = np.array([100,200,300])
discount = 10 #
(variable) prices: NDArray[Any]
final_prices = prices - (prices * discount/100)
print(final_prices)

```
arr1 = np.array([[1,2,3],[4,5,6]]) #shapre(2,3)
arr2 = np.array([1,2]) #shape(2,)

result = arr1 + arr2

print(result)
```

```
Traceback (most recent call last):
  File "/Users/sagarchouksey/Desktop/Numpy for Data-Science/Broadcasting/error.py", line 6, in <module>
    result = arr1 + arr2
ValueError: operands could not be broadcast together with shapes (2,3) (2,)
```

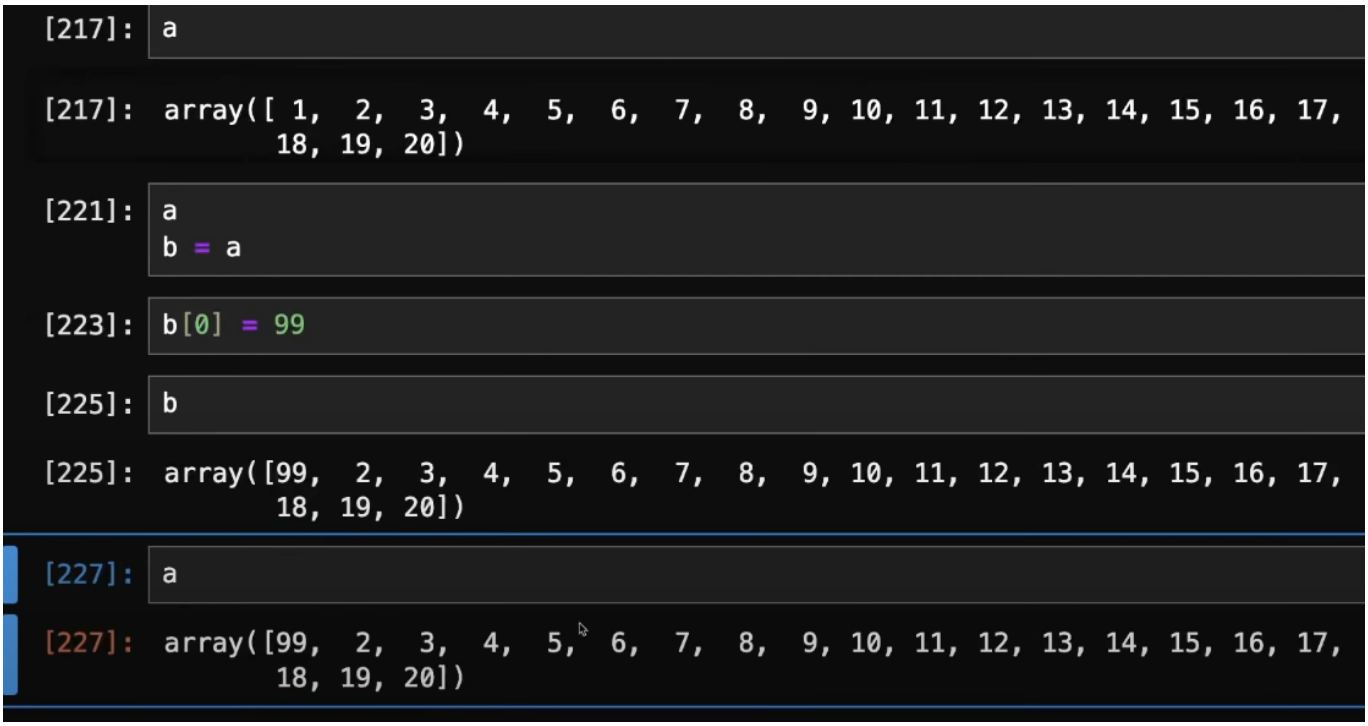
DEEP COPY AND SHALLOW COPY

Deep copy আর shallow copy

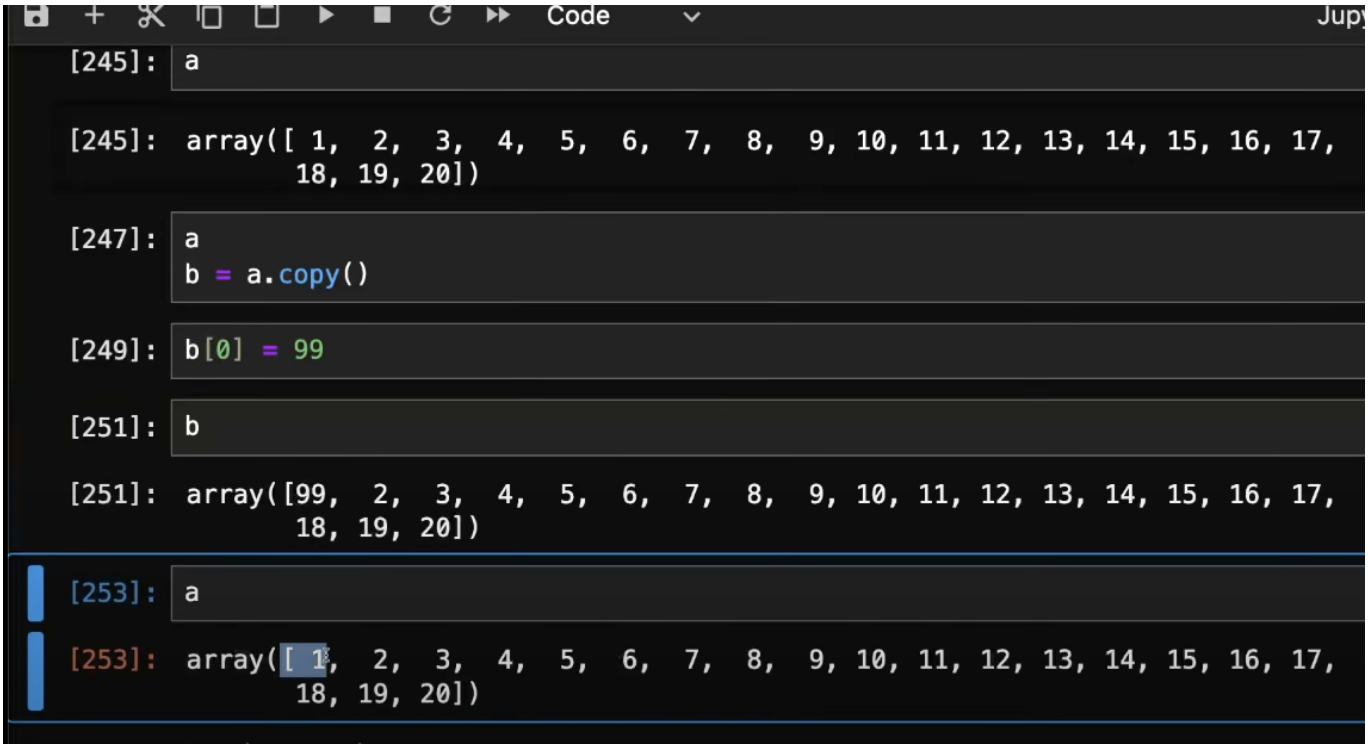
Deep copy হত list এর মধ্যে যেখানে আমরা slice করে broadcasting / arithmetic operation করতাম তখন main list এ change হয়ে যেত । But array এর মধ্যে হচ্ছে shallow copy এখানে আমরা slice করে নিলে আর সেখানে পরিবর্তন করলে আমাদের main array এর মধ্যে পরিবর্তন হবে না ।

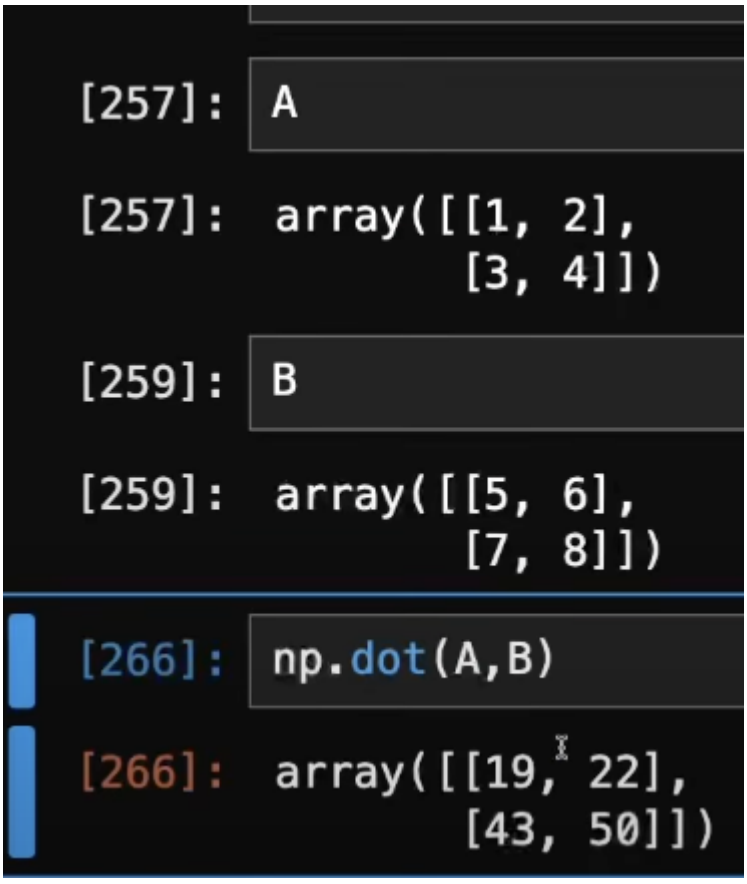
Deep and Shallow copy

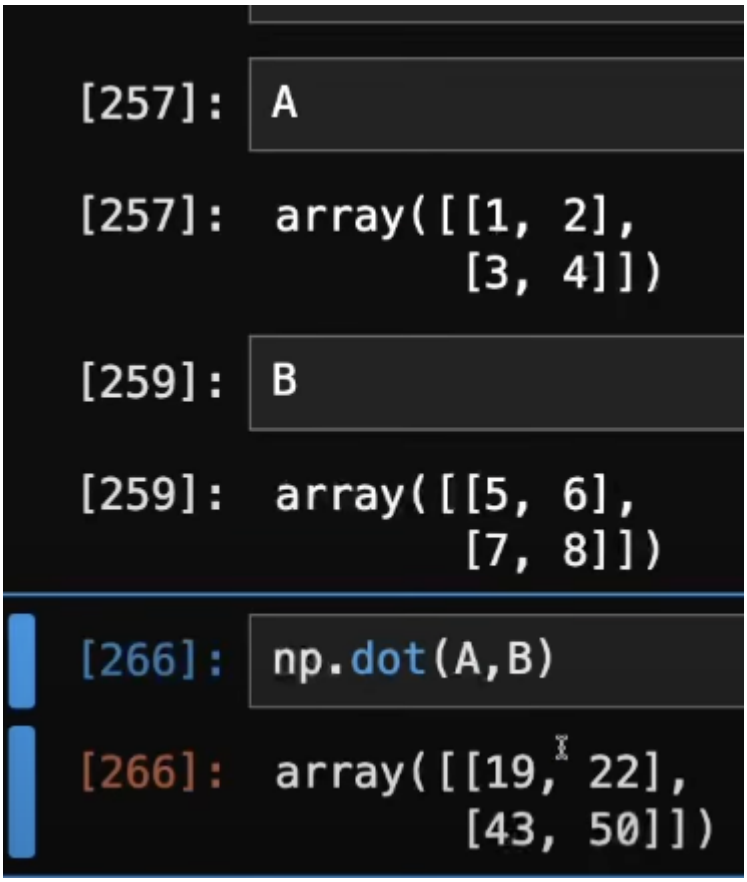
```
[199]: a = np.arange(1,21)
       a

[199]: array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16, 17,
              18, 19, 20])

[201]: slice = a[:5]
       slice = slice *10
       slice

[201]: array([10, 20, 30, 40, 50])

[203]: a

[203]: array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16, 17,
              18, 19, 20])
```



কিন্তু আমরা যদি deep copy না চাই তাহলে আমরা array a এর থেকে copy করে b তে রাখলে তাহলে b = a.copy() ফাঙ্কশন নিব।

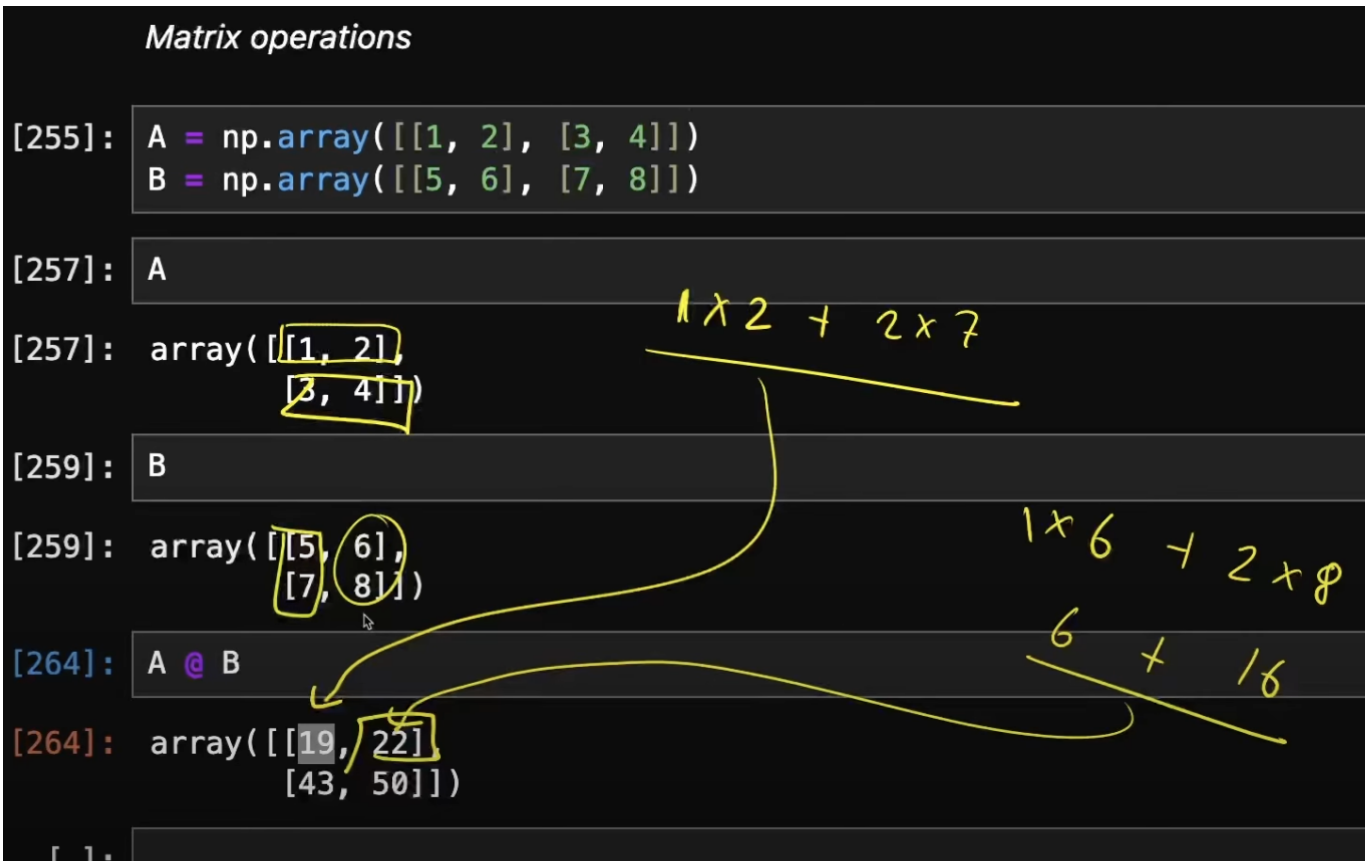

Code
[245]: a
[245]: array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20])
[247]: a
b = a.copy()
[249]: b[0] = 99
[251]: b
[251]: array([99, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20])
[253]: a
[253]: array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20])


[257]: A
[257]: array([[1, 2],
[3, 4]])
[259]: B
[259]: array([[5, 6],
[7, 8]])
[266]: np.dot(A,B)
[266]: array([[19, 22],
[43, 50]])

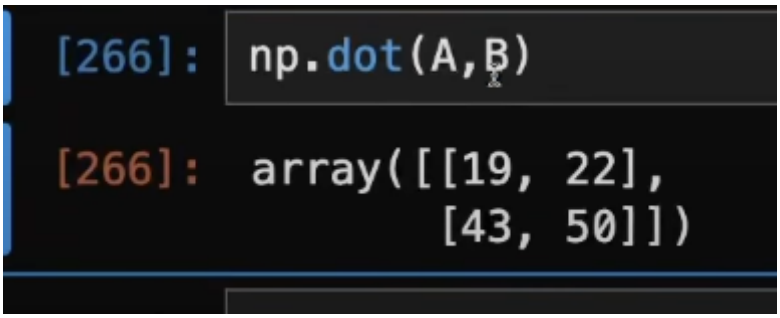


Matrix operation

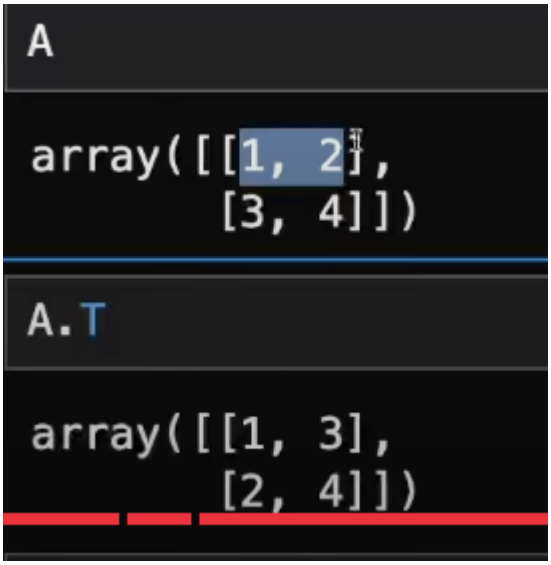
Matrix Multiplication : using @ sign



Also like that we can a multiplication to b

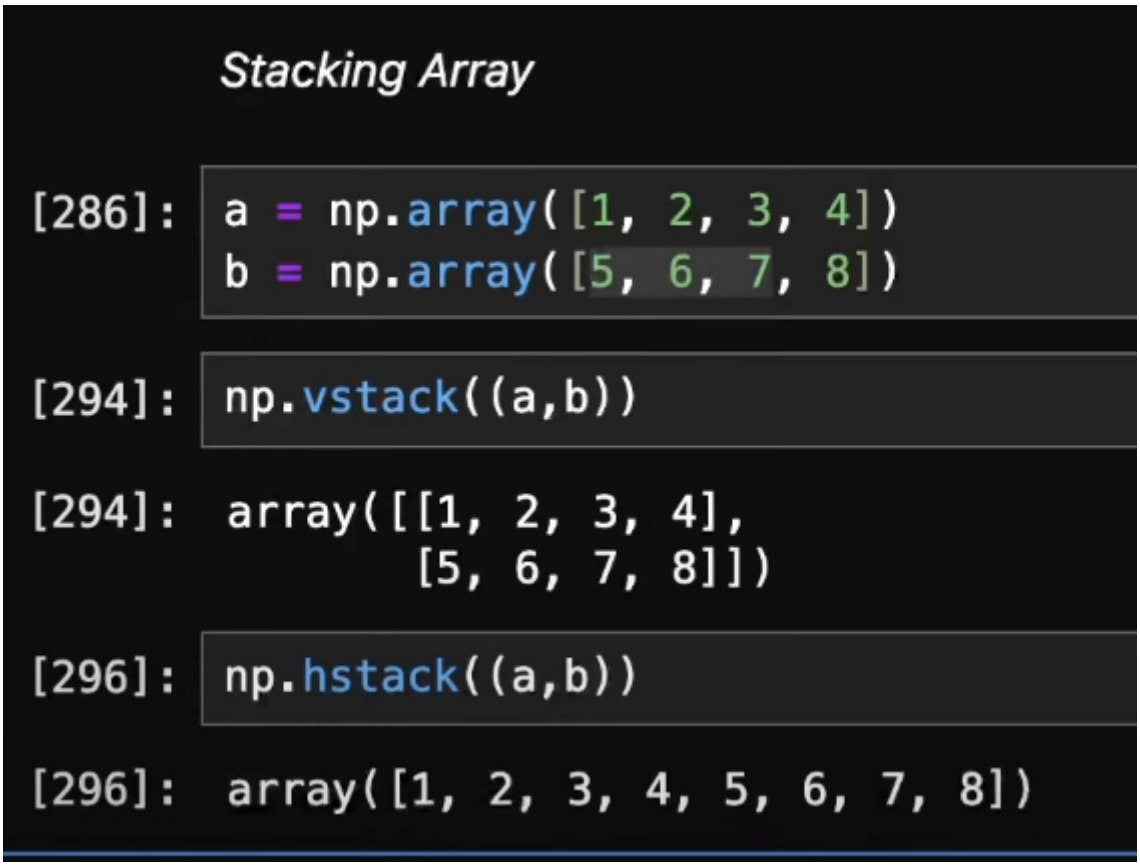


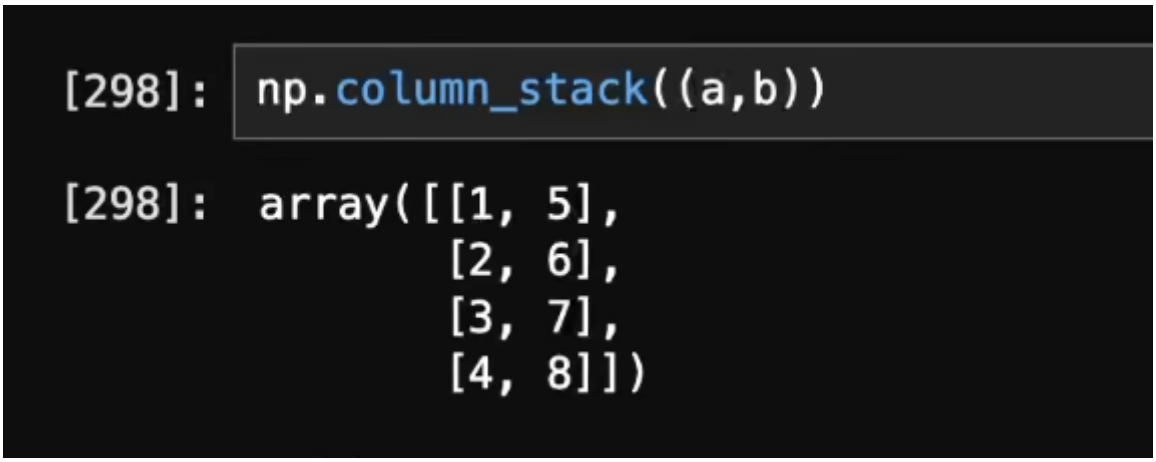
Transpose matrix : row convert into column and column convert into row .



ARRAY MODIFICATION

Split & Stack

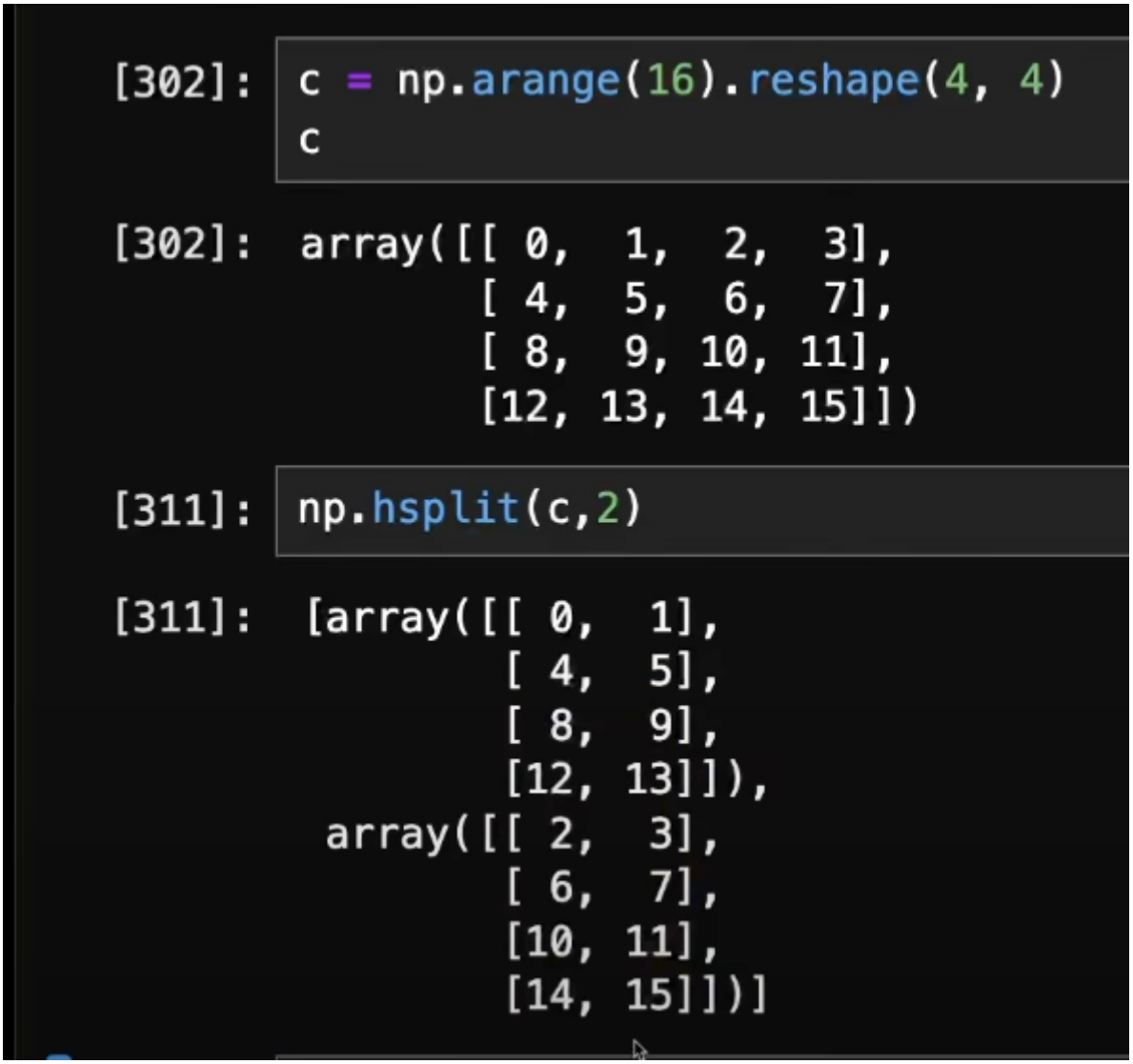




We can’t stack two matrix we can stack two array / vector . Stack মনে দুইটা array / vector কে জোড়া লাগানো। আমরা stack তিনভাবে করতে পারি vertical stack বা horizontal stack বা column_stack((a,b)) np.vstack((a,b)) বা horizontally np.hstack((a,b)), np.column_stack((a,b)) .

Split 2d array তে থাকে।

সমান পার্ট এ করতে হবে split . 3 টা করতে গেলে error আসবে।



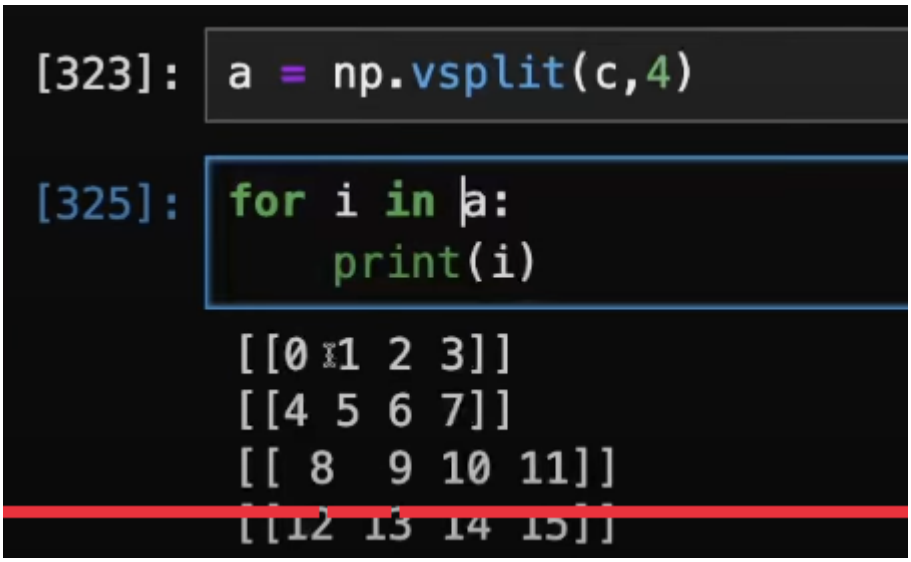
```
np.hsplit(c,4)

[array([[ 0],
        [ 4],
        [ 8],
        [12]]),
 array([[ 1],
        [ 5],
        [ 9],
        [13]]),
 array([[ 2],
        [ 6],
        [10],
        [14]]),
 array([[ 3],
        [ 7],
        [11],
        [15]])]
```

4 টা split .

ভার্টিকাল স্প্লিট।

```
7]: np.vsplit(c,2)

7]: [array([[0, 1, 2, 3],
            [4, 5, 6, 7]]),
     array([[ 8,  9, 10, 11],
            [12, 13, 14, 15]])]
```

```
np.vsplit(c,4)

[array([[0, 1, 2, 3]]),
 array([[4, 5, 6, 7]]),
 array([[ 8,  9, 10, 11]]),
 array([[12, 13, 14, 15]])]
```



INSERT

আমরা কোন array এর মধ্যে নতুন element insert করতে পারি না কারণ তার সাইজ ফিক্সড থাকে । আমরা যখন insert operation চালাই তখন মেইন array এর কপি তৈরি হয়।

```
arr = np.array([10,20,30,40,50,60])
print(arr)
new_arr = np.insert(arr, 2, 100)
print(new_arr)
```

Axis = 0 মানে row wise insert operation চলবে।

```
arr_2d = np.array([[1,2],[3,4]])
print(arr_2d)
#insert a new row at index 1
new_arr_2d = np.insert(arr_2d, 1, [5,6], axis=1)
print(new_arr_2d)
```

Axis = None মানে flatten copy করবে। 1d array তে insert করবে।