

Numpy Crash Course

```
In [1]: import numpy as np
```

```
In [2]: np.__version__
```

```
Out[2]: '1.26.4'
```

Creatin Arrays

```
In [3]: my_list=[0,1,2,3,4,5]  
my_list
```

```
Out[3]: [0, 1, 2, 3, 4, 5]
```

```
In [5]: type(my_list)
```

```
Out[5]: list
```

```
In [7]: arr=np.array(my_list)
```

```
In [8]: arr
```

```
Out[8]: array([0, 1, 2, 3, 4, 5])
```

```
In [10]: type(arr)
```

```
Out[10]: numpy.ndarray
```

```
In [11]: np.arange(15)
```

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

```
In [12]: np.arange(3.0)
```

```
Out[12]: array([0., 1., 2.])
```

```
In [13]: np.arange(0,5)
```

```
Out[13]: array([0, 1, 2, 3, 4])
```

```
In [14]: np.arange(10,20)
```

```
Out[14]: array([10, 11, 12, 13, 14, 15, 16, 17, 18, 19])
```

```
In [15]: np.arange(20,10)
```

```
Out[15]: array([], dtype=int32)
```

```
In [16]: np.arange(-20,10)
```

```
Out[16]: array([-20, -19, -18, -17, -16, -15, -14, -13, -12, -11, -10, -9, -8,
 -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5,
 6, 7, 8, 9])
```

```
In [17]: np.arange(-20,-10)
```

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

```
In [18]: np.arange(10,10)
```

```
Out[18]: array([], dtype=int32)
```

```
In [19]: np.arange(-1000,1000)
```

```
Out[19]: array([-1000, -999, -998, ..., 997, 998, 999])
```

```
In [20]: np.arange(10,30,5)
```

```
Out[20]: array([10, 15, 20, 25])
```

```
In [21]: np.zeros(5)
```

```
Out[21]: array([0., 0., 0., 0., 0.])
```

```
In [22]: np.zeros(5,dtype=int)
```

```
Out[22]: array([0, 0, 0, 0, 0])
```

```
In [23]: np.zeros((10,10))
```

```
Out[23]: 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., 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., 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., 0., 0., 0., 0.]])
```

```
In [24]: np.zeros((10,10),dtype=int)
```

```
In [25]: zero=np.zeros([2,2])
          type(zero)
```

Out[25]: numpy.ndarray

```
In [26]: np.zeros((2,10))
```

```
Out[26]: 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.]])
```

```
In [27]: n=(6,7)
         n1=(6,8)
         print(np.zeros(n))
```

```
In [28]: print(np.zeros(n1,dtype=int))
```

```
In [29]: np.ones(4, dtype=int)
```

```
Out[29]: array([1, 1, 1, 1])
```

```
In [30]: np.ones((5, 4), dtype=int)
```

```
Out[30]: array([[1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1]])
```

```
In [31]: range(5)
```

```
Out[31]: range(0, 5)
```

```
In [32]: r=range(5)
r
```

```
Out[32]: range(0, 5)
```

```
In [33]: for i in r:
    print(i)
```

```
0
1
2
3
4
```

```
In [34]: list(range(5))
[0,1,2,3,4]
```

```
Out[34]: [0, 1, 2, 3, 4]
```

```
In [35]: list(range(5))
[0,1,2,3,4]
```

```
Out[35]: [0, 1, 2, 3, 4]
```

```
In [36]: range(1,10)
```

```
Out[36]: range(1, 10)
```

```
In [37]: list(range(1,10))
```

```
Out[37]: [1, 2, 3, 4, 5, 6, 7, 8, 9]
```

```
In [39]: list(range(1,20,3))
```

```
Out[39]: [1, 4, 7, 10, 13, 16, 19]
```

```
In [40]: y=list(range(12))
y
```

```
Out[40]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

```
In [41]: np.random.rand(3,2)
```

```
Out[41]: array([[0.28718124, 0.24988118],
                [0.79523383, 0.55934544],
                [0.99148995, 0.99259113]])
```

```
In [42]: np.random.rand(4)
```

```
Out[42]: array([0.89483186, 0.42033695, 0.99410799, 0.42576254])
```

```
In [44]: np.random.rand(3,6)
```

```
Out[44]: array([[0.11635698, 0.19457403, 0.01954021, 0.67363637, 0.02067767,
   0.34568781],
   [0.46227536, 0.80315852, 0.66890588, 0.29781105, 0.03632532,
   0.82963004],
   [0.45388837, 0.12655784, 0.5899013 , 0.34190246, 0.68166773,
   0.13980535]])
```

```
In [45]: np.random.randint(2,4)
```

```
Out[45]: 3
```

```
In [46]: np.random.randint(3,79)
```

```
Out[46]: 73
```

```
In [47]: np.random.randint(0,1)
```

```
Out[47]: 0
```

```
In [48]: np.random.randint(1,2,3)
```

```
Out[48]: array([1, 1, 1])
```

```
In [49]: np.random.randint(1)
```

```
Out[49]: 0
```

```
In [50]: np.random.randint(10,21,3)
```

```
Out[50]: array([12, 16, 15])
```

```
In [52]: np.random.randint(1,12,10)
```

```
Out[52]: array([ 5,  9,  9, 10,  7,  4,  8,  5,  9,  4])
```

```
In [53]: np.random.randint(10,40,(10,10))
```

```
Out[53]: array([[17, 31, 29, 25, 13, 20, 15, 33, 27, 12],
   [36, 21, 22, 16, 11, 38, 13, 15, 23, 36],
   [17, 16, 19, 12, 30, 32, 31, 18, 12, 23],
   [17, 28, 33, 30, 20, 22, 28, 11, 21, 29],
   [14, 13, 34, 12, 23, 25, 11, 16, 36, 27],
   [12, 30, 12, 19, 29, 33, 21, 30, 33, 12],
   [34, 27, 33, 15, 25, 21, 13, 29, 25, 33],
   [17, 17, 22, 29, 22, 18, 20, 15, 32, 12],
   [32, 19, 36, 27, 21, 25, 23, 33, 30],
   [20, 14, 19, 33, 22, 26, 25, 15, 14, 36]])
```

```
In [54]: b=np.random.randint(10,20,(5,4))
```

```
b
```

```
Out[54]: array([[18, 10, 17, 19],
 [17, 12, 15, 16],
 [11, 13, 19, 16],
 [16, 14, 15, 16],
 [18, 16, 12, 18]])
```

" ":"- is used for slicing, we need to

provide rows and columns among the slicing point

```
In [55]: b[:]
```

```
Out[55]: array([[18, 10, 17, 19],
 [17, 12, 15, 16],
 [11, 13, 19, 16],
 [16, 14, 15, 16],
 [18, 16, 12, 18]])
```

```
In [56]: b[0:-1]
```

```
Out[56]: array([[18, 10, 17, 19],
 [17, 12, 15, 16],
 [11, 13, 19, 16],
 [16, 14, 15, 16]])
```

"," is used to get specific indexing number

```
In [57]: b[0,2]
```

```
Out[57]: 17
```

```
In [58]: np.random.randint(10,20,(4,4))
```

```
Out[58]: array([[19, 10, 14, 19],
 [19, 16, 18, 18],
 [17, 17, 12, 11],
 [15, 10, 19, 14]])
```

Operation

```
In [59]: a=np.random.randint(10,20,5)
a
```

```
Out[59]: array([16, 13, 17, 18, 13])
```

```
In [60]: arr
```

```
Out[60]: array([0, 1, 2, 3, 4, 5])
```

```
In [61]: arr2=np.random.randint(0,100,(100,10))
arr2
```

```
Out[61]: array([[49,  7, 72, 10, 63, 33, 75, 21, 69, 85],  
   [97, 29, 81, 33, 11, 57, 53,  4, 21, 28],  
   [89, 19,  8, 62, 37, 97,  0, 12, 35, 94],  
   [86, 65, 80, 27, 56, 17, 30, 43, 74, 57],  
   [ 6, 32, 51, 47, 59, 17,  8, 43, 14, 57],  
   [11, 61, 20, 56, 93,  9,  6, 29, 26, 87],  
   [18, 64, 47, 27, 48, 51, 95,  7, 99, 81],  
   [23, 51, 75, 53, 85, 12, 56, 68, 60, 12],  
   [59, 41, 62, 30, 53, 17, 97, 92, 42, 94],  
   [75, 91, 11, 80, 20, 67, 48, 68, 62, 16],  
   [93, 19, 75, 55, 87, 94, 89, 35, 20, 83],  
   [27, 52, 84, 29,  0,  8, 85, 61, 78, 96],  
   [ 6, 69, 28, 60, 32, 93, 22, 44, 41, 66],  
   [87, 23, 53, 27, 22,  8,  8, 80,  4, 52],  
   [57,  8, 99,  7, 70, 40, 43, 65, 43, 94],  
   [14, 44, 31, 46, 41, 42,  2, 16, 23, 32],  
   [85, 23, 72, 73, 50, 70, 73, 73, 70,  9],  
   [11, 21, 74, 55, 23, 66, 19, 43, 57,  1],  
   [20, 73, 85, 33, 83, 66, 10, 46, 28, 93],  
   [75,  4, 18, 38, 58, 21, 36, 85, 98, 18],  
   [31, 19, 44, 22, 14, 93,  9, 43, 76, 52],  
   [94, 46, 17, 43, 46, 27, 34, 82, 13, 78],  
   [84, 79, 62,  1, 76, 66, 39, 93, 45, 73],  
   [63, 72, 14, 36, 89, 38, 48, 32, 80, 86],  
   [35, 13, 39, 88, 21, 12, 19, 21, 47, 75],  
   [27, 33, 79, 30, 70, 25, 11, 99, 75, 88],  
   [50, 98, 56, 73, 66, 78, 44, 46,  7, 65],  
   [61, 68, 22, 16,  6, 15, 38, 12, 71, 35],  
   [68,  6, 73, 34, 30, 26, 54, 88, 99, 97],  
   [90, 32, 68, 34, 23,  1, 90, 30, 91, 37],  
   [37, 79,  2, 77, 72, 96, 41, 96, 60, 53],  
   [34, 44, 44, 97, 11, 71, 59, 77, 26, 82],  
   [36,  4, 61, 28, 41, 34,  0, 34,  7, 39],  
   [20, 68, 37,  5, 92, 26, 27, 97, 71,  5],  
   [76, 48, 27,  7, 27, 14, 38, 92, 58, 60],  
   [40, 67, 20, 78, 99, 12,  3, 81,  8,  1],  
   [67, 67, 61,  9, 26, 18, 55, 95, 55, 23],  
   [ 9, 57,  0, 28, 33, 78, 81, 92, 88, 38],  
   [ 8,  5, 67, 34, 44, 73, 95, 15, 16, 76],  
   [65, 23, 50,  2, 45, 94, 96, 11, 36, 26],  
   [75, 66, 46,  5, 49, 51, 10, 31, 62, 97],  
   [20,  4, 87, 28, 71, 96, 29,  6, 27, 40],  
   [83, 68, 25,  0, 66, 77, 71, 20, 57,  9],  
   [69, 25, 43, 35, 14, 50, 51, 67,  2, 31],  
   [15, 22, 30, 43, 67, 91, 34, 63, 29, 32],  
   [68, 30, 91, 90, 94, 38, 30, 34, 62, 34],  
   [88, 63, 10, 40, 36,  0, 24, 10, 73, 53],  
   [77, 22, 69, 41, 67, 29, 58, 95, 80, 37],  
   [67, 87, 10, 61, 97, 10, 41, 71, 14, 42],  
   [36, 95,  2, 66,  3, 11, 82, 46, 89, 16],  
   [71, 79, 79, 39, 68, 86, 32, 92, 66, 60],  
   [11, 48, 59, 78, 33, 10, 15, 24, 36, 10],  
   [21, 44, 70, 38, 75,  0, 16, 51, 72, 57],  
   [93, 89,  1, 42, 97, 72, 59, 40, 61, 38],  
   [70, 61,  3, 51, 11, 40, 20, 51,  6, 48],  
   [80, 37, 86, 85, 85, 41,  1, 23, 14, 70],
```

```
[62, 52, 71, 11, 72, 84, 34, 46, 76, 93],  
[78, 89, 99, 65, 70, 19, 30, 13, 14, 35],  
[46, 10, 68, 54, 79, 3, 4, 41, 58, 7],  
[53, 41, 27, 43, 84, 43, 74, 91, 32, 40],  
[2, 25, 45, 62, 8, 80, 23, 33, 66, 74],  
[10, 56, 33, 52, 46, 92, 60, 62, 69, 41],  
[76, 31, 99, 23, 61, 11, 49, 33, 74, 8],  
[38, 23, 26, 73, 22, 20, 35, 21, 1, 43],  
[86, 71, 5, 68, 5, 79, 84, 65, 75, 22],  
[95, 0, 54, 85, 97, 79, 64, 60, 62, 71],  
[40, 90, 20, 9, 55, 53, 39, 51, 51, 25],  
[58, 3, 7, 24, 50, 45, 99, 76, 93, 21],  
[50, 31, 57, 69, 43, 23, 58, 52, 13, 14],  
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[92, 60, 32, 16, 72, 92, 53, 69, 15, 95],  
[84, 59, 33, 93, 47, 93, 59, 51, 71, 11],  
[15, 17, 82, 40, 79, 33, 90, 60, 53, 89],  
[58, 84, 82, 12, 2, 83, 3, 70, 65, 73],  
[6, 47, 49, 58, 46, 95, 39, 40, 15, 27],  
[50, 75, 85, 27, 77, 44, 5, 25, 44, 95],  
[42, 89, 77, 45, 60, 20, 56, 72, 12, 41],  
[86, 27, 21, 50, 41, 93, 1, 82, 5, 2],  
[81, 5, 24, 34, 61, 61, 52, 92, 0, 4],  
[53, 74, 73, 46, 6, 59, 68, 75, 52, 46],  
[77, 12, 20, 4, 61, 27, 4, 65, 98, 42],  
[72, 62, 17, 14, 38, 94, 22, 32, 81, 17],  
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[70, 26, 99, 18, 90, 62, 13, 29, 43, 12],  
[75, 32, 41, 27, 71, 45, 85, 21, 69, 97],  
[59, 73, 95, 84, 13, 76, 72, 8, 7, 23],  
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[38, 86, 34, 18, 27, 48, 68, 93, 14, 37],  
[67, 23, 76, 7, 42, 83, 8, 51, 47, 90]])
```

```
In [62]: arr
```

```
Out[62]: array([0, 1, 2, 3, 4, 5])
```

```
In [63]: arr[:]
```

```
Out[63]: array([0, 1, 2, 3, 4, 5])
```

```
In [64]: arr[:4]
```

```
Out[64]: array([0, 1, 2, 3])
```

```
In [65]: arr2[:]
```

```
Out[65]: array([[49,  7, 72, 10, 63, 33, 75, 21, 69, 85],  
   [97, 29, 81, 33, 11, 57, 53,  4, 21, 28],  
   [89, 19,  8, 62, 37, 97,  0, 12, 35, 94],  
   [86, 65, 80, 27, 56, 17, 30, 43, 74, 57],  
   [ 6, 32, 51, 47, 59, 17,  8, 43, 14, 57],  
   [11, 61, 20, 56, 93,  9,  6, 29, 26, 87],  
   [18, 64, 47, 27, 48, 51, 95,  7, 99, 81],  
   [23, 51, 75, 53, 85, 12, 56, 68, 60, 12],  
   [59, 41, 62, 30, 53, 17, 97, 92, 42, 94],  
   [75, 91, 11, 80, 20, 67, 48, 68, 62, 16],  
   [93, 19, 75, 55, 87, 94, 89, 35, 20, 83],  
   [27, 52, 84, 29,  0,  8, 85, 61, 78, 96],  
   [ 6, 69, 28, 60, 32, 93, 22, 44, 41, 66],  
   [87, 23, 53, 27, 22,  8,  8, 80,  4, 52],  
   [57,  8, 99,  7, 70, 40, 43, 65, 43, 94],  
   [14, 44, 31, 46, 41, 42,  2, 16, 23, 32],  
   [85, 23, 72, 73, 50, 70, 73, 73, 70,  9],  
   [11, 21, 74, 55, 23, 66, 19, 43, 57,  1],  
   [20, 73, 85, 33, 83, 66, 10, 46, 28, 93],  
   [75,  4, 18, 38, 58, 21, 36, 85, 98, 18],  
   [31, 19, 44, 22, 14, 93,  9, 43, 76, 52],  
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   [27, 33, 79, 30, 70, 25, 11, 99, 75, 88],  
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   [61, 68, 22, 16,  6, 15, 38, 12, 71, 35],  
   [68,  6, 73, 34, 30, 26, 54, 88, 99, 97],  
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   [ 9, 57,  0, 28, 33, 78, 81, 92, 88, 38],  
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   [20,  4, 87, 28, 71, 96, 29,  6, 27, 40],  
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   [93, 89,  1, 42, 97, 72, 59, 40, 61, 38],  
   [70, 61,  3, 51, 11, 40, 20, 51,  6, 48],  
   [80, 37, 86, 85, 85, 41,  1, 23, 14, 70],
```

```
[62, 52, 71, 11, 72, 84, 34, 46, 76, 93],  
[78, 89, 99, 65, 70, 19, 30, 13, 14, 35],  
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[15, 17, 82, 40, 79, 33, 90, 60, 53, 89],  
[58, 84, 82, 12, 2, 83, 3, 70, 65, 73],  
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[53, 74, 73, 46, 6, 59, 68, 75, 52, 46],  
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Out[67]: 28
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Out[69]: 92

In [70]: arr2[-7,-7]

Out[70]: 80

In [71]: arr2

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In [73]: arr2

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```

In [74]: arr2[::-2]

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```

```
In [75]: arr2
```

```
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[67, 23, 76, 7, 42, 83, 8, 51, 47, 90]])
```

In [76]: arr2[::5]

```
Out[76]: array([[49,  7, 72, 10, 63, 33, 75, 21, 69, 85],  
                 [11, 61, 20, 56, 93,  9,  6, 29, 26, 87],  
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                 [37, 75, 31, 81, 19,  1, 38, 61, 47, 85],  
                 [97, 12, 42, 54, 12, 75, 26, 57, 63, 43]])
```

```
In [77]: arr
```

```
Out[77]: array([0, 1, 2, 3, 4, 5])
```

```
In [78]: arr.max()
```

```
Out[78]: 5
```

```
In [79]: arr.max()
```

```
Out[79]: 5
```

```
In [80]: arr.min()
```

```
Out[80]: 0
```

```
In [81]: arr.mean()
```

```
Out[81]: 2.5
```

```
In [84]: from numpy import *  
a = array([1,2,3,4,9])  
median(a)
```

```
Out[84]: 3.0
```

```
In [85]: arr
```

```
Out[85]: array([0, 1, 2, 3, 4, 5])
```

```
In [86]: arr.reshape(2,3)
```

```
Out[86]: array([[0, 1, 2],
   [3, 4, 5]])
```

```
In [88]: arr.reshape(6,1)
```

```
Out[88]: array([0,
   [1],
   [2],
   [3],
   [4],
   [5]])
```

```
In [90]: arr.reshape(1,6)
```

```
Out[90]: array([[0, 1, 2, 3, 4, 5]])
```

```
In [91]: arr
```

```
Out[91]: array([0, 1, 2, 3, 4, 5])
```

Only three type of orders are there in reshape C- Type F- Type A- Type

C type indexing order

```
In [94]: arr.reshape(3,2,order='c')
```

```
Out[94]: array([[0, 1],
   [2, 3],
   [4, 5]])
```

F- fortran indexing order

```
In [96]: arr.reshape(3,2,order='F')
```

```
Out[96]: array([[0, 3],
   [1, 4],
   [2, 5]])
```

```
In [97]: arr.reshape(2,3,order='F')
```

```
Out[97]: array([[0, 2, 4],
   [1, 3, 5]])
```

```
In [98]: array([[0,2,4],[1,3,5]])
```

```
Out[98]: array([[0, 2, 4],
   [1, 3, 5]])
```

A-Arbitrary indexing order

```
In [99]: arr.reshape(3,2,order='A')
```

```
Out[99]: array([[0, 1],  
                 [2, 3],  
                 [4, 5]])
```

```
In [100... arr.reshape(2,3)
```

```
Out[100... array([[0, 1, 2],  
                  [3, 4, 5]])
```

```
In [101... arr.reshape(1,6)
```

```
Out[101... array([[0, 1, 2, 3, 4, 5]])
```

```
In [102... arr.reshape(6,1)
```

```
Out[102... array([[0],  
                  [1],  
                  [2],  
                  [3],  
                  [4],  
                  [5]])
```

```
In [103... arr
```

```
Out[103... array([0, 1, 2, 3, 4, 5])
```

```
In [104... arr.shape
```

```
Out[104... (6, )
```

```
In [105... arr
```

```
Out[105... array([0, 1, 2, 3, 4, 5])
```

```
In [106... arr.reshape(3,2)
```

```
Out[106... array([[0, 1],  
                  [2, 3],  
                  [4, 5]])
```

Indexing

```
In [109... mat=np.arange(0,100).reshape(10,10)  
mat
```

```
Out[109... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [110... row=4  
col=5
```

```
In [111... col
```

```
Out[111... 5
```

```
In [112... row
```

```
Out[112... 4
```

```
In [113... mat
```

```
Out[113... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [114... mat[row,col]
```

```
Out[114... 45
```

```
In [115... mat[4,5]
```

```
Out[115... 45
```

```
In [116... mat
```

```
Out[116... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [117... mat[:]
```

```
Out[117... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [118... col=6
```

```
In [119... mat
```

```
Out[119... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [120... mat[:,col]
```

```
Out[120... array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [121... row
```

```
Out[121... 4
```

```
In [122... mat[row,:]
```

```
Out[122... array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [123... mat
```

```
Out[123... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [124... mat[:col]
```

```
Out[124... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])
```

```
In [125... mat
```

```
Out[125... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [126... row
```

```
Out[126... 4
```

```
In [127... mat[:row]
```

```
Out[127... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39]])
```

```
In [128... mat[:]
```

```
Out[128... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [129... mat[:,8]
```

```
Out[129... array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

```
In [130... mat[:, -1]
```

```
Out[130... array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

```
In [131... mat
```

```
Out[131... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [132... row
```

```
Out[132... 4
```

```
In [133... col
```

```
Out[133... 6
```

```
In [134... mat
```

```
Out[134... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [135... mat[:, col]
```

```
Out[135... array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [136... mat
```

```
Out[136... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [137... mat[1,4]
```

```
Out[137... 14
```

```
In [138... mat
```

```
Out[138... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [139... mat[3,-3]
```

```
Out[139... 37
```

```
In [140... mat
```

```
Out[140... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [141... mat[0]
```

```
Out[141... array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [142... mat[6]
```

```
Out[142... array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

```
In [143... mat
```

```
Out[143... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [144... mat[6:]
```

```
Out[144... array([[60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [145... mat[:6]
```

```
Out[145... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])
```

```
In [146... mat
```

```
Out[146... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [147... mat[5:7]
```

```
Out[147... array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])
```

```
In [148... mat
```

```
Out[148... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [149... mat[0:10]
```

```
Out[149... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [150... mat[0:10:3]
```

```
Out[150... array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [151... mat[4:]
```

```
Out[151... array([[40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [152... mat[:4]
```

```
Out[152... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39]])
```

```
In [153... mat[::-1]
```

```
Out[153... array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],  
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],  
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],  
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],  
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],  
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],  
   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],  
   [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],  
   [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],  
   [ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9]])
```

```
In [154... mat[::-2]
```

```
Out[154... array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],  
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],  
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],  
   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],  
   [10, 11, 12, 13, 14, 15, 16, 17, 18, 19]])
```

```
In [155... mat
```

```
Out[155... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],  
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],  
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],  
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],  
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],  
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],  
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [156... mat[2:6,2:4]
```

```
Out[156... array([[22, 23],  
   [32, 33],  
   [42, 43],  
   [52, 53]])
```

```
In [157... mat[1:2,2:4]
```

```
Out[157... array([[12, 13]])
```

```
In [158... mat
```

```
Out[158... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],  
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],  
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],  
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],  
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],  
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],  
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [159... mat[2:3,4:5]
```

```
Out[159... array([[24]])
```

Masking also called as Filter

```
In [160... mat
```

```
Out[160... array([[ 0,  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, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [161... id(mat)
```

```
Out[161... 2557987032688
```

```
In [163... mat<50
```

```
Out[163... array([[ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [ True,  True,  True,  True,  True,  True,  True,  True,  True,
       True],
       [False, False, False, False, False, False, False, False, False,
       False],
       [False, False, False, False, False, False, False, False, False,
       False],
       [False, False, False, False, False, False, False, False, False,
       False],
       [False, False, False, False, False, False, False, False, False,
       False],
       [False, False, False, False, False, False, False, False, False,
       False]])
```

```
In [164... mat==50
```

In [165...]: mat[mat==50]

Out[165... array([50])

```
In [167]: a1=mat[mat<50]  
a1
```

```
Out[167... array([ 0,  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, 31, 32, 33,
   34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [169]: a2=mat[mat<50]  
a2
```

```
Out[169...]: array([ 0,  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, 31, 32, 33,
                     34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [170]: a3=mat[mat==50]  
a3
```

Out[170... array([50])

In [171... a1

```
Out[171... array([ 0,  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, 31, 32, 33,
   34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [172... a2

```
Out[172... array([ 0,  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, 31, 32, 33,
   34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [173... a3

Out[173... array([50])

In []:

In []: