

NumPy

```
In [2]: import numpy as np
```

```
In [3]: np.__version__
```

```
Out[3]: '1.21.5'
```

Creating Arrays

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

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

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

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

```
In [6]: # how to convert list into array
```

```
In [7]: my_list
```

```
Out[7]: [0, 1, 2, 3, 4, 5]
```

```
In [8]: arr = np.array(my_list)
arr
```

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

```
In [9]: print(type(arr))
```

```
<class 'numpy.ndarray'>
```

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

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

```
In [13]: np.arange(10,20)
```

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

```
In [14]: np.arange(20,30)
```

```
Out[14]: array([20, 21, 22, 23, 24, 25, 26, 27, 28, 29])
```

```
In [15]: np.arange(10,20,5)
```

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

```
In [16]: np.arange(10,50,5)
```

```
Out[16]: array([10, 15, 20, 25, 30, 35, 40, 45])
```

```
In [17]: np.arange(20,10) # 1st arg < 2nd arg
```

```
Out[17]: array([], dtype=int32)
```

```
In [18]: np.arange(-20,10)
```

```
Out[18]: 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 [19]: np.arange(-16,10)
```

```
Out[19]: array([-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 [20]: np.arange(-20,-10)
```

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

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

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

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

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

```
In [23]: np.zeros([2,2])
```

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

```
In [24]: np.zeros([5,4])
```

```
Out[24]: array([[0., 0., 0., 0.], [0., 0., 0., 0.], [0., 0., 0., 0.], [0., 0., 0., 0.], [0., 0., 0., 0.]])
```

```
In [25]: np.zeros((10,10), dtype = int)
```

```
Out[25]: 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 [26]: np.ones(2)
```

```
Out[26]: array([1., 1.])
```

```
In [27]: np.ones(2, dtype=int)
```

```
Out[27]: array([1, 1])
```

```
In [28]: np.ones([2,2])
```

```
Out[28]: array([[1., 1.],
 [1., 1.]])
```

```
In [29]: np.ones([4,5])
```

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

```
In [30]: arr
```

```
Out[30]: array([0, 1, 2, 3, 4, 5])
```

Operations

```
In [31]: rand(3,2)
```

```
NameError
```

```
Input In [31], in <cell line: 1>()
----> 1 rand(3,2)
```

```
Traceback (most recent call last)
```

```
NameError: name 'rand' is not defined
```

```
In [32]: random.rand(3,2)
```

```
NameError Traceback (most recent call last)
Input In [32], in <cell line: 1>()
      1 random.rand(3,2)

NameError: name 'random' is not defined
```

```
In [33]: np.random.rand(3,2)
```

```
Out[33]: array([[0.27491139, 0.13656428],
 [0.7136617 , 0.92996035],
 [0.36110393, 0.2671377 ]])
```

```
In [34]: np.random.rand(3)
```

```
Out[34]: array([0.72043537, 0.93616916, 0.9918894 ])
```

```
In [35]: np.random.randint(4,6)
```

```
Out[35]: 4
```

```
In [36]: np.random.randint(0,10)
```

```
Out[36]: 3
```

```
In [37]: np.random.randint(0,10,4)
```

```
Out[37]: array([8, 6, 0, 1])
```

```
In [38]: np.random.randint(0,10,5)
```

```
Out[38]: array([1, 6, 4, 0, 4])
```

```
In [39]: n = np.random.randint(10,40,(10,10))
n
```

```
Out[39]: array([[13, 24, 31, 19, 16, 23, 10, 34, 12, 31],
 [28, 31, 24, 17, 37, 13, 22, 31, 39, 26],
 [31, 36, 27, 14, 13, 39, 23, 27, 12, 13],
 [16, 21, 27, 12, 27, 13, 21, 12, 11, 32],
 [10, 18, 28, 20, 31, 19, 35, 27, 33, 39],
 [23, 18, 16, 20, 16, 37, 12, 31, 21, 23],
 [34, 25, 38, 17, 37, 31, 38, 37, 14, 27],
 [14, 35, 26, 30, 37, 21, 16, 16, 23, 33],
 [38, 13, 22, 28, 26, 18, 24, 10, 30, 22],
 [19, 21, 29, 20, 18, 28, 32, 31, 29, 34]])
```

```
In [40]: n = np.random.randint(10,40,(8,10))
```

```
In [41]: n
```

```
Out[41]: array([[38, 30, 17, 11, 16, 12, 33, 29, 17, 10],  
                 [20, 26, 19, 21, 34, 23, 10, 29, 25, 13],  
                 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],  
                 [20, 35, 26, 10, 12, 32, 36, 35, 34, 27],  
                 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],  
                 [27, 29, 35, 15, 37, 20, 39, 35, 14, 25],  
                 [35, 33, 30, 13, 31, 19, 26, 29, 15, 22],  
                 [27, 28, 16, 38, 15, 27, 30, 26, 34, 13]])
```

```
In [42]: n[0]
```

```
Out[42]: array([38, 30, 17, 11, 16, 12, 33, 29, 17, 10])
```

```
In [43]: n[5]
```

```
Out[43]: array([27, 29, 35, 15, 37, 20, 39, 35, 14, 25])
```

```
In [44]: n[0:6]
```

```
Out[44]: array([[38, 30, 17, 11, 16, 12, 33, 29, 17, 10],  
                 [20, 26, 19, 21, 34, 23, 10, 29, 25, 13],  
                 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],  
                 [20, 35, 26, 10, 12, 32, 36, 35, 34, 27],  
                 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],  
                 [27, 29, 35, 15, 37, 20, 39, 35, 14, 25]])
```

```
In [45]: n[::-1]
```

```
Out[45]: array([[27, 28, 16, 38, 15, 27, 30, 26, 34, 13],  
                 [35, 33, 30, 13, 31, 19, 26, 29, 15, 22],  
                 [27, 29, 35, 15, 37, 20, 39, 35, 14, 25],  
                 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],  
                 [20, 35, 26, 10, 12, 32, 36, 35, 34, 27],  
                 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],  
                 [20, 26, 19, 21, 34, 23, 10, 29, 25, 13],  
                 [38, 30, 17, 11, 16, 12, 33, 29, 17, 10]])
```

```
In [46]: n[::-1]
```

```
Out[46]: array([[38, 30, 17, 11, 16, 12, 33, 29, 17, 10],  
                 [20, 26, 19, 21, 34, 23, 10, 29, 25, 13],  
                 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],  
                 [20, 35, 26, 10, 12, 32, 36, 35, 34, 27],  
                 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],  
                 [27, 29, 35, 15, 37, 20, 39, 35, 14, 25],  
                 [35, 33, 30, 13, 31, 19, 26, 29, 15, 22],  
                 [27, 28, 16, 38, 15, 27, 30, 26, 34, 13]])
```

```
In [47]: n[::-2]
```

```
Out[47]: array([[38, 30, 17, 11, 16, 12, 33, 29, 17, 10],  
                 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],  
                 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],  
                 [35, 33, 30, 13, 31, 19, 26, 29, 15, 22]])
```

```
In [48]: n[0]
```

```
Out[48]: array([38, 30, 17, 11, 16, 12, 33, 29, 17, 10])
```

```
In [49]: n
```

```
Out[49]: array([[38, 30, 17, 11, 16, 12, 33, 29, 17, 10],
 [20, 26, 19, 21, 34, 23, 10, 29, 25, 13],
 [33, 25, 31, 35, 36, 12, 22, 21, 29, 28],
 [20, 35, 26, 10, 12, 32, 36, 35, 34, 27],
 [29, 21, 29, 12, 14, 28, 34, 16, 13, 38],
 [27, 29, 35, 15, 37, 20, 39, 35, 14, 25],
 [35, 33, 30, 13, 31, 19, 26, 29, 15, 22],
 [27, 28, 16, 38, 15, 27, 30, 26, 34, 13]])
```

```
In [50]: n[0,5]
```

```
Out[50]: 12
```

```
In [51]: n[5,-3]
```

```
Out[51]: 35
```

```
In [52]: np.arange(1,13).reshape(3,4)
```

```
Out[52]: array([[ 1,  2,  3,  4],
 [ 5,  6,  7,  8],
 [ 9, 10, 11, 12]])
```

```
In [53]: np.arange(1,13).reshape(5,5)
```

```
-----  
ValueError                                     Traceback (most recent call last)  
Input In [53], in <cell line: 1>()  
----> 1 np.arange(1,13).reshape(5,5)  
  
ValueError: cannot reshape array of size 12 into shape (5,5)
```

```
In [54]: np.arange(1,13).reshape(4,3)
```

```
Out[54]: array([[ 1,  2,  3],
 [ 4,  5,  6],
 [ 7,  8,  9],
 [10, 11, 12]])
```

```
In [55]: np.arange(1,13).reshape(2,6)
```

```
Out[55]: array([[ 1,  2,  3,  4,  5,  6],
 [ 7,  8,  9, 10, 11, 12]])
```

```
In [56]: np.arange(1,13).reshape(6,2)
```

```
Out[56]: array([[ 1,  2],  
                 [ 3,  4],  
                 [ 5,  6],  
                 [ 7,  8],  
                 [ 9, 10],  
                [11, 12]])
```

Indexing

```
In [57]: mat = np.arange(0,100).reshape(10,10)
```

```
In [58]: mat
```

```
Out[58]: 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 [59]: row = 4  
col = 5
```

```
In [60]: col
```

```
Out[60]: 5
```

```
In [61]: row
```

```
Out[61]: 4
```

```
In [62]: mat[row,col]
```

```
Out[62]: 45
```

```
In [63]: mat[4,5]
```

```
Out[63]: 45
```

```
In [64]: mat[7]
```

```
Out[64]: array([70, 71, 72, 73, 74, 75, 76, 77, 78, 79])
```

```
In [65]: mat
```

```
Out[65]: 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 [66]: # With Slices
mat[:,col] # how to print column
```

```
Out[66]: array([ 5, 15, 25, 35, 45, 55, 65, 75, 85, 95])
```

```
In [67]: mat[col] # how to print rows
```

```
Out[67]: array([50, 51, 52, 53, 54, 55, 56, 57, 58, 59])
```

```
In [68]: mat[:, -1]
```

```
Out[68]: array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

```
In [69]: mat[:, 4]
```

```
Out[69]: array([ 4, 14, 24, 34, 44, 54, 64, 74, 84, 94])
```

```
In [70]: mat[4]
```

```
Out[70]: array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [71]: mat[row, :]
```

```
Out[71]: array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [72]: mat[:, 8]
```

```
Out[72]: array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

```
In [73]: mat[row:]
```

```
Out[73]: 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 [74]: mat[5:]
```

```
Out[74]: array([[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 [75]: mat[:row]
```

```
Out[75]: 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 [76]: mat[:6]
```

```
Out[76]: 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 [77]: mat[:col]
```

```
Out[77]: 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 [78]: mat[:7]
```

```
Out[78]: 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]])
```

```
In [79]: mat[2:6,2:4]
```

```
Out[79]: array([[22, 23],  
                 [32, 33],  
                 [42, 43],  
                 [52, 53]])
```

```
In [80]: mat[1:2,2:4]
```

```
Out[80]: array([[12, 13]])
```

```
In [81]: mat[2:4,3:5]
```

```
Out[81]: array([[23, 24],  
                 [33, 34]])
```

MASKING

```
In [82]: mat # we also called as filter
```

```
Out[82]: 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 [83]: id(mat)
```

```
Out[83]: 1953367447760
```

```
In [84]: mat < 50
```

```
Out[84]: array([[ 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 [85]: mat[mat < 50]
```

```
Out[85]: 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 [86]: mat[mat != 50]
```

```
Out[86]: 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, 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 [87]: mat[mat = 50]
```

```
Input In [87]
mat[mat = 50]
^
SyntaxError: invalid syntax
```

```
In [88]: mat[mat == 50]
```

```
Out[88]: array([50])
```

```
In [89]: mat[mat > 50]
```

```
Out[89]: array([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 [90]: mat[mat >= 50]
```

```
Out[90]: array([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])
```

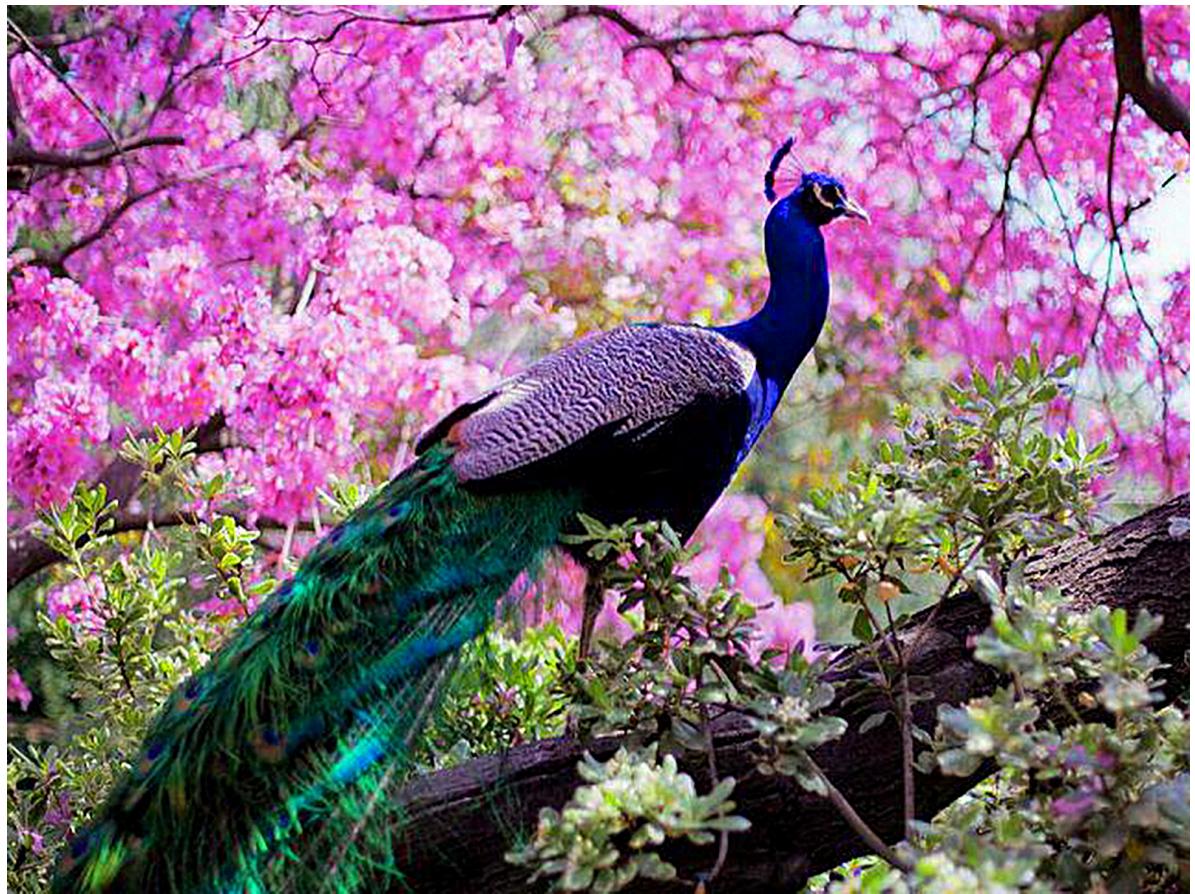
How to read image using NP + PIL

```
In [97]: import matplotlib.pyplot as plt
```

```
In [98]: from PIL import Image
```

```
In [99]: peacock_image = Image.open(r"C:\Users\sidra\Pictures\peacock.jpeg")
peacock_image
```

Out[99]:



```
In [100]: doreamon_image = Image.open(r"C:\Users\sidra\Pictures\doreamon.jpg")
doreamon_image
```

Out[100]:

