Assignment_numpy

September 10, 2021

1   100 numpy exercises

This is a collection of exercises that have been collected in the numpy mailing list, on stack overflow and in the numpy documentation. The goal of this collection is to offer a quick reference for both old and new users but also to provide a set of exercises for those who teach.

If you find an error or think you've a better way to solve some of them, feel free to open an issue at https://github.com/rougier/numpy-100.

File automatically generated. See the documentation to update questions/answers/hints programmatically.

Run the `initialize.py` module, then for each question you can query the answer or an hint with `hint(n)` or `answer(n)` for `n` question number.

```
[1]: #run initialise.py
```

1. Import the numpy package under the name `np` ( )

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

2. Print the numpy version and the configuration ( )

```
[3]: print(np.__version__)
     print(np.show_config())
```

```
1.20.2
blas_mkl_info:
  NOT AVAILABLE
blis_info:
  NOT AVAILABLE
openblas_info:
    library_dirs = ['D:\\a\\1\\s\\numpy\\build\\openblas_info']
    libraries = ['openblas_info']
    language = f77
    define_macros = [('HAVE_CBLAS', None)]
blas_opt_info:
    library_dirs = ['D:\\a\\1\\s\\numpy\\build\\openblas_info']
    libraries = ['openblas_info']
    language = f77
```

```
        define_macros = [('HAVE_CBLAS', None)]
lapack_mkl_info:
  NOT AVAILABLE
openblas_lapack_info:
    library_dirs = ['D:\\a\\1\\s\\numpy\\build\\openblas_lapack_info']
    libraries = ['openblas_lapack_info']
    language = f77
    define_macros = [('HAVE_CBLAS', None)]
lapack_opt_info:
    library_dirs = ['D:\\a\\1\\s\\numpy\\build\\openblas_lapack_info']
    libraries = ['openblas_lapack_info']
    language = f77
    define_macros = [('HAVE_CBLAS', None)]
None
```

3. Create a null vector of size 10 ( )

```
[4]: n_vector=np.zeros(10)
```

4. How to find the memory size of any array ( )

```
[5]: v_size=n_vector.size
     ele_byte=n_vector.itemsize
     print("No. of elements in array: %i and Memory size of one element: %i␣
      ↪bytes"%(ele_byte,v_size))
     memo_size=v_size*ele_byte
     print("Memory size of array",memo_size)
```

```
No. of elements in array: 8 and Memory size of one element: 10 bytes
Memory size of array 80
```

5. How to get the documentation of the numpy add function from the command line? ( )

```
[6]: #python -c "import numpy as np; np.info(np.add)"
     print(np.info(np.add))
```

```
add(x1, x2, /, out=None, *, where=True, casting='same_kind', order='K',
dtype=None, subok=True[, signature, extobj])

Add arguments element-wise.

Parameters
----------
x1, x2 : array_like
    The arrays to be added.
    If ``x1.shape != x2.shape``, they must be broadcastable to a common
    shape (which becomes the shape of the output).
out : ndarray, None, or tuple of ndarray and None, optional
    A location into which the result is stored. If provided, it must have
```

```
        a shape that the inputs broadcast to. If not provided or None,
        a freshly-allocated array is returned. A tuple (possible only as a
        keyword argument) must have length equal to the number of outputs.
where : array_like, optional
        This condition is broadcast over the input. At locations where the
        condition is True, the `out` array will be set to the ufunc result.
        Elsewhere, the `out` array will retain its original value.
        Note that if an uninitialized `out` array is created via the default
        ``out=None``, locations within it where the condition is False will
        remain uninitialized.
**kwargs
        For other keyword-only arguments, see the
        :ref:`ufunc docs <ufuncs.kwargs>`.

Returns
-------
add : ndarray or scalar
        The sum of `x1` and `x2`, element-wise.
        This is a scalar if both `x1` and `x2` are scalars.

Notes
-----
Equivalent to `x1` + `x2` in terms of array broadcasting.

Examples
--------
>>> np.add(1.0, 4.0)
5.0
>>> x1 = np.arange(9.0).reshape((3, 3))
>>> x2 = np.arange(3.0)
>>> np.add(x1, x2)
array([[  0.,   2.,   4.],
       [  3.,   5.,   7.],
       [  6.,   8.,  10.]])

The ``+`` operator can be used as a shorthand for ``np.add`` on ndarrays.

>>> x1 = np.arange(9.0).reshape((3, 3))
>>> x2 = np.arange(3.0)
>>> x1 + x2
array([[ 0.,  2.,  4.],
       [ 3.,  5.,  7.],
       [ 6.,  8., 10.]])
None
```

6. Create a null vector of size 10 but the fifth value which is 1 ( )

```
[7]: n_vector=np.zeros(10)
     n_vector[5-1]=1
     print(n_vector)
```

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

7. Create a vector with values ranging from 10 to 49 ( )

```
[8]: arr_50 = np.arange(10,49+1)
     print(arr_50)
```

[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]

8. Reverse a vector (first element becomes last) ( )

```
[9]: r_arr1=np.flipud(arr_50)
     r_arr2=arr_50[::-1]
     print(r_arr1)
     print(r_arr2)
```

[49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26
 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10]
[49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26
 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10]

9. Create a 3x3 matrix with values ranging from 0 to 8 ( )

```
[10]: arr_9=np.arange(9)
      arr_33=arr_9.reshape(3,3)
      print(arr_33)
```

[[0 1 2]
 [3 4 5]
 [6 7 8]]

10. Find indices of non-zero elements from [1,2,0,0,4,0] ( )

```
[11]: arr=np.array([1,2,0,0,4,0])
      i_nonzero=np.nonzero(arr)
      print("Non-zero index", i_nonzero)
```

Non-zero index (array([0, 1, 4], dtype=int64),)

11. Create a 3x3 identity matrix ( )

```
[12]: I=np.eye(3)
      print(I)
```

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

```

**12. Create a 3x3x3 array with random values ( )**

```python
em=np.empty((3,3,3))
print("Constant random 3*3*3 array: \n",em)
array=np.random.random((3,3,3))
print("Variable random 3*3*3 array: \n",array)
```

```
Constant random 3*3*3 array:
 [[[1.16067724e-311 1.16067740e-311 7.63123655e-167]
  [6.67268208e-313 4.57400437e-308 1.33360305e+241]
  [1.87117589e-310 6.04608850e-138 7.73367997e-313]]

 [[8.18974939e-308 1.33360311e+241 2.52305300e-310]
  [3.06836125e+257 8.73989992e+245 1.10808956e-303]
  [8.36326332e-299 8.51026301e+014 5.87391645e-294]]

 [[1.41411134e-096 1.04875248e-144 1.28075797e+116]
  [8.88943504e-039 8.98732138e+303 5.58899589e+019]
  [5.30381249e+180 3.15412224e-307 1.16070662e-311]]]
Variable random 3*3*3 array:
 [[[0.86817643 0.20890163 0.90177512]
  [0.9247451  0.59603603 0.30241864]
  [0.74267756 0.62865276 0.49467015]]

 [[0.32597738 0.42852271 0.33429416]
  [0.12697229 0.6091856  0.13054535]
  [0.48281497 0.32237915 0.51440817]]

 [[0.4943193  0.23953305 0.66041165]
  [0.5254926  0.54805598 0.29764925]
  [0.77655259 0.27191229 0.13141573]]]
```

13. Create a 10x10 array with random values and find the minimum and maximum values ( )

```python
r_array=np.random.random((10,10))
min_=np.min(array)
max_=np.max(array)
print("Minimum value is %f and maximum value is %f."%(min_,max_))
```

```
Minimum value is 0.126972 and maximum value is 0.924745.
```

14. Create a random vector of size 30 and find the mean value ( )

```python
array=np.random.random((30))
mean_=np.mean(array)
print("Mean : ",mean_)
```

```
Mean :  0.4479428014234593
```

15. Create a 2d array with 1 on the border and 0 inside ( )

```
[16]: array = np.ones((4,5))
      array[1:-1,1:-1]=0
      print(array)
```

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

16. How to add a border (filled with 0's) around an existing array? ( )

```
[17]: arr=np.full((5,5),5)
      arr = np.pad(arr, pad_width=1, mode='constant', constant_values=0)
      print(arr)
```

```
[[0 0 0 0 0 0 0]
 [0 5 5 5 5 5 0]
 [0 5 5 5 5 5 0]
 [0 5 5 5 5 5 0]
 [0 5 5 5 5 5 0]
 [0 5 5 5 5 5 0]
 [0 0 0 0 0 0 0]]
```

17. What is the result of the following expression? ( )

```
0 * np.nan
np.nan == np.nan
np.inf > np.nan
np.nan - np.nan
np.nan in set([np.nan])
0.3 == 3 * 0.1
```

```
[18]: #nan
      #False
      #False
      #nan
      #True
      #False
```

18. Create a 5x5 matrix with values 1,2,3,4 just below the diagonal ( )

```
[19]: Z = np.diag(np.arange(1,5),k=-1)
      print(Z)
```

```
[[0 0 0 0 0]
 [1 0 0 0 0]
 [0 2 0 0 0]
 [0 0 3 0 0]
 [0 0 0 4 0]]
```

19. Create a 8x8 matrix and fill it with a checkerboard pattern ( )

```
[20]: Z = np.zeros ((8,8), dtype=int)
      Z[1::2, ::2]= 1
      #Z[::2, 1::2] = 1
      print (Z)
```

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

20. Consider a (6,7,8) shape array, what is the index (x,y,z) of the 100th element? ( )

```
[21]: arr=np.array((6,7,8))
      in_100=np.unravel_index(100, arr)
      print (in_100)
```

```
(1, 5, 4)
```

21. Create a checkerboard 8x8 matrix using the tile function ( )

```
[22]: arr = np.zeros((8,8),dtype=int)
      arr[::2,::2] = 1
      arr[1::2,1::2] = 1
      print(arr)
```

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

22. Normalize a 5x5 random matrix ( )

```
[23]: array=np.random.random((5,5))
      array = (array - np.mean (array)) / (np.std (array))
      print(array)
```

```
[[-0.57118214 -1.56670569  0.31792227  1.22292275 -1.46390024]
 [ 0.17400288  0.76659553 -1.14994861 -1.44757887 -0.46769793]
 [ 0.11989239  1.06826238 -1.34514896  1.05905455  0.6638668 ]
 [ 1.10437841 -0.47847575  1.40836181  1.2673934  -1.17685832]
 [ 1.04966882  1.00366531 -0.93351765 -0.09061123 -0.53436192]]
```

23. Create a custom dtype that describes a color as four unsigned bytes (RGBA) ( )

```
[24]: RGBA = np.dtype([('red', np.ubyte),('green', np.ubyte),('blue', np.
      →ubyte),('alpha', np.ubyte)])
```

24. Multiply a 5x3 matrix by a 3x2 matrix (real matrix product) ( )

```
[25]: mat_1=np.random.random((5,3))
      mat_2=np.random.random((3,2))
      mult=np.dot(mat_1,mat_2)
      print(mult)
```

```
[[1.70183628 1.3481226 ]
 [1.28582666 1.04931752]
 [1.27239264 1.18730542]
 [1.49106951 1.39152571]
 [0.75041901 0.43360279]]
```

25. Given a 1D array, negate all elements which are between 3 and 8, in place. ( )

```
[26]: arr=np.random.random(10)*10
      #arr = np.arange(16)
      arr[(arr>=3) & (arr<=8)]*=(-1)
      print(arr)
```

```
[ 0.88119486 -3.52774613 -5.90637184  8.99171254 -5.20992086  9.64216855
 -5.1969198   1.88765469  8.15595435  9.77981026]
```

26. What is the output of the following script? ( )

```
# Author: Jake VanderPlas

print(sum(range(5),-1))
from numpy import *
print(sum(range(5),-1))
```

```
[27]: #print(sum(range(5),-1))
      #9
      #from numpy import *
      #print(sum(range(5),-1))
      #10
```

27. Consider an integer vector Z, which of these expressions are legal? ( )

```
Z**Z
2 << Z >> 2
Z <- Z
1j*Z
Z/1/1
Z<Z>Z
```

```
[28]: #These expression are legal
      #Z**Z
      #2 << Z >> 2
      #Z <- Z
      #1j*Z
      #Z/1/1

      #this expression is not legal
      #Z<Z>Z
```

28. What are the result of the following expressions? ( )

```
np.array(0) / np.array(0)
np.array(0) // np.array(0)
np.array([np.nan]).astype(int).astype(float)
```

```
[29]: #nan
      #0
      #[-2.14748365e+09]
```

29. How to round away from zero a float array ? ( )

```
[30]: arr=np.array([5.45, 3.5, 0.11, 1.6, 0.64])
      print(arr)
      arr=np.round(arr,0)
      print(arr)
```

```
[5.45 3.5  0.11 1.6  0.64]
[5. 4. 0. 2. 1.]
```

30. How to find common values between two arrays? ( )

```
[31]: arr1 = np.random.randint(0,10,10)
      arr2 = np.random.randint(0,10,10)
      print(arr1,arr2)
      print(np.intersect1d(arr1,arr2))
```

```
[4 8 2 0 3 5 2 2 5 3] [4 0 7 3 3 6 9 0 1 2]
[0 2 3 4]
```

31. How to ignore all numpy warnings (not recommended)? ( )

```
[32]: #defaults = np.seterr(all="ignore")
      #Z = np.ones(1) / 0
```

32. Is the following expressions true? ( )

```
np.sqrt(-1) == np.emath.sqrt(-1)
```

```
[33]: print(np.sqrt(-1) == np.emath.sqrt(-1))
```

```
False
```

```
<ipython-input-33-c6ff0ad7fd7b>:1: RuntimeWarning: invalid value encountered in
sqrt
  print(np.sqrt(-1) == np.emath.sqrt(-1))
```

33. How to get the dates of yesterday, today and tomorrow? ( )

```
[34]: today     = np.datetime64('today')
      yesterday = np.datetime64('today') - np.timedelta64(1)
      tomorrow  = np.datetime64('today') + np.timedelta64(1)
```

34. How to get all the dates corresponding to the month of July 2016? ( )

```
[35]: arr = np.arange('2016-07', '2016-08', dtype='datetime64[D]')
      print(arr)
```

```
['2016-07-01' '2016-07-02' '2016-07-03' '2016-07-04' '2016-07-05'
 '2016-07-06' '2016-07-07' '2016-07-08' '2016-07-09' '2016-07-10'
 '2016-07-11' '2016-07-12' '2016-07-13' '2016-07-14' '2016-07-15'
 '2016-07-16' '2016-07-17' '2016-07-18' '2016-07-19' '2016-07-20'
 '2016-07-21' '2016-07-22' '2016-07-23' '2016-07-24' '2016-07-25'
 '2016-07-26' '2016-07-27' '2016-07-28' '2016-07-29' '2016-07-30'
 '2016-07-31']
```

35. How to compute ((A+B)*(-A/2)) in place (without copy)? ( )

```
[36]: A = np.ones(3)*2
      B = np.ones(3)*2
      np.add(A,B,out=B)
      np.divide(A,2,out=A)
      np.negative(A,out=A)
      arr=np.multiply(A, B)
      print(arr)
```

```
[-4. -4. -4.]
```

36. Extract the integer part of a random array of positive numbers using 4 different methods ( )

```
[37]: arr = np.array([1.2,0.1,5.2,6,4,7.4,2.4,9])
      print (arr - arr%1)
      print (np.floor(arr))
      print (np.ceil(arr)-1)
      print (arr.astype(int))
      print (np.trunc(arr))
```

```
[1. 0. 5. 6. 4. 7. 2. 9.]
[1. 0. 5. 6. 4. 7. 2. 9.]
[1. 0. 5. 5. 3. 7. 2. 8.]
[1 0 5 6 4 7 2 9]
[1. 0. 5. 6. 4. 7. 2. 9.]
```

37. Create a 5x5 matrix with row values ranging from 0 to 4 ( )

```
[38]: arr = np.zeros((5,5))
      arr += np.arange(5)
      print(arr)
```

```
[[0. 1. 2. 3. 4.]
 [0. 1. 2. 3. 4.]
 [0. 1. 2. 3. 4.]
 [0. 1. 2. 3. 4.]
 [0. 1. 2. 3. 4.]]
```

38. Consider a generator function that generates 10 integers and use it to build an array ( )

```
[39]: def generate_fn():
          for i in range(10):
              yield i
      np.fromiter(generate_fn(), dtype=int, count=10)
```

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

39. Create a vector of size 10 with values ranging from 0 to 1, both excluded ( )

```
[40]: np.linspace(0,1,12)[1:-1]
```

```
[40]: array([0.09090909, 0.18181818, 0.27272727, 0.36363636, 0.45454545,
             0.54545455, 0.63636364, 0.72727273, 0.81818182, 0.90909091])
```

40. Create a random vector of size 10 and sort it ( )

```
[41]: arr=np.random.random(10)
      np.sort(arr)
```

```
[41]: array([0.01124987, 0.01406728, 0.05734812, 0.10548303, 0.26287208,
             0.26985685, 0.34698184, 0.49187197, 0.91784722, 0.962562  ])
```

41. How to sum a small array faster than np.sum? ( )

```
[42]: arr = np.arange(20)
      print(arr)
      np.add.reduce(arr)
      # This work only for small array
```

```
[ 0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19]
```

```
[42]: 190
```

42. Consider two random array A and B, check if they are equal ( )

```
[43]: arr1 = np.random.randint(0,3,10)
      arr2 = np.random.randint(0,3,10)
      comparison = arr1 == arr2
      if_equal=comparison.all()
```

```
print(if_equal)
```

False

43. Make an array immutable (read-only) ( )

```
[44]: arr = np.random.randint(0,2,10)
      arr.flags.writeable = False
```

44. Consider a random 10x2 matrix representing cartesian coordinates, convert them to polar coordinates ( )

```
[45]: arr = np.random.random((10,2))
      print(arr)
      x = arr[:,0]
      y = arr[:,1]
      r = np.sqrt(x**2+y**2)
      angle = np.arctan2(y,x)
      print(r)
      print(angle)
```

```
[[0.05526435 0.12476368]
 [0.49214821 0.03223394]
 [0.6590653  0.59867595]
 [0.50523305 0.31238615]
 [0.60613023 0.00742009]
 [0.70800183 0.37565727]
 [0.37280479 0.22238848]
 [0.17928574 0.56452644]
 [0.39894855 0.6088845 ]
 [0.38095867 0.56033757]]
[0.13645558 0.49320269 0.89038192 0.59400803 0.60617565 0.80148922
 0.43409681 0.59231198 0.7279425  0.67757487]
[1.15381881 0.065403   0.73742088 0.55376761 0.01224112 0.48781751
 0.53786261 1.26328461 0.99076572 0.97370617]
```

45. Create random vector of size 10 and replace the maximum value by 0 ( )

```
[46]: arr = np.random.random(10)
      i_max=np.argmax(arr)
      print(arr)
      arr[i_max]=0
      print(arr)
```

```
[0.84147367 0.40939995 0.02421972 0.00962465 0.84219935 0.62592038
 0.59183946 0.6608687  0.82214544 0.22592152]
[0.84147367 0.40939995 0.02421972 0.00962465 0.         0.62592038
 0.59183946 0.6608687  0.82214544 0.22592152]
```

46. Create a structured array with x and y coordinates covering the [0,1]x[0,1] area ( )

```python
[47]: arr = np.zeros((10,10), [('x',float),('y',float)])
      x=np.linspace(0,1,10)
      y=np.linspace(0,1,10)
      arr['x'], arr['y'] = np.meshgrid(x,y)
      print(arr)
```

```
[[(0.        , 0.        ) (0.11111111, 0.        )
  (0.22222222, 0.        ) (0.33333333, 0.        )
  (0.44444444, 0.        ) (0.55555556, 0.        )
  (0.66666667, 0.        ) (0.77777778, 0.        )
  (0.88888889, 0.        ) (1.        , 0.        )]
 [(0.        , 0.11111111) (0.11111111, 0.11111111)
  (0.22222222, 0.11111111) (0.33333333, 0.11111111)
  (0.44444444, 0.11111111) (0.55555556, 0.11111111)
  (0.66666667, 0.11111111) (0.77777778, 0.11111111)
  (0.88888889, 0.11111111) (1.        , 0.11111111)]
 [(0.        , 0.22222222) (0.11111111, 0.22222222)
  (0.22222222, 0.22222222) (0.33333333, 0.22222222)
  (0.44444444, 0.22222222) (0.55555556, 0.22222222)
  (0.66666667, 0.22222222) (0.77777778, 0.22222222)
  (0.88888889, 0.22222222) (1.        , 0.22222222)]
 [(0.        , 0.33333333) (0.11111111, 0.33333333)
  (0.22222222, 0.33333333) (0.33333333, 0.33333333)
  (0.44444444, 0.33333333) (0.55555556, 0.33333333)
  (0.66666667, 0.33333333) (0.77777778, 0.33333333)
  (0.88888889, 0.33333333) (1.        , 0.33333333)]
 [(0.        , 0.44444444) (0.11111111, 0.44444444)
  (0.22222222, 0.44444444) (0.33333333, 0.44444444)
  (0.44444444, 0.44444444) (0.55555556, 0.44444444)
  (0.66666667, 0.44444444) (0.77777778, 0.44444444)
  (0.88888889, 0.44444444) (1.        , 0.44444444)]
 [(0.        , 0.55555556) (0.11111111, 0.55555556)
  (0.22222222, 0.55555556) (0.33333333, 0.55555556)
  (0.44444444, 0.55555556) (0.55555556, 0.55555556)
  (0.66666667, 0.55555556) (0.77777778, 0.55555556)
  (0.88888889, 0.55555556) (1.        , 0.55555556)]
 [(0.        , 0.66666667) (0.11111111, 0.66666667)
  (0.22222222, 0.66666667) (0.33333333, 0.66666667)
  (0.44444444, 0.66666667) (0.55555556, 0.66666667)
  (0.66666667, 0.66666667) (0.77777778, 0.66666667)
  (0.88888889, 0.66666667) (1.        , 0.66666667)]
 [(0.        , 0.77777778) (0.11111111, 0.77777778)
  (0.22222222, 0.77777778) (0.33333333, 0.77777778)
  (0.44444444, 0.77777778) (0.55555556, 0.77777778)
  (0.66666667, 0.77777778) (0.77777778, 0.77777778)
  (0.88888889, 0.77777778) (1.        , 0.77777778)]
 [(0.        , 0.88888889) (0.11111111, 0.88888889)
  (0.22222222, 0.88888889) (0.33333333, 0.88888889)
```

```
       (0.44444444, 0.88888889) (0.55555556, 0.88888889)
       (0.66666667, 0.88888889) (0.77777778, 0.88888889)
       (0.88888889, 0.88888889) (1.         , 0.88888889)]
      [(0.        , 1.         ) (0.11111111, 1.         )
       (0.22222222, 1.         ) (0.33333333, 1.         )
       (0.44444444, 1.         ) (0.55555556, 1.         )
       (0.66666667, 1.         ) (0.77777778, 1.         )
       (0.88888889, 1.         ) (1.         , 1.         )]]
```

47. Given two arrays, X and Y, construct the Cauchy matrix C (Cij =1/(xi - yj)) ( )

```
[48]: x = np.random.random(5)
      y = np.random.random(5)
      X = x.reshape((-1,1))
      c=1/(X-y)
      c
```

```
[48]: array([[  9.71978071, -59.85181673,  -2.8106863 ,  -3.7409477 ,
               -1.42174737],
             [  3.62383261,   6.39549653,  -5.47294346, -10.6107565 ,
               -1.88575392],
             [  1.87748195,   2.42108838,  13.52076366,   6.15637057,
               -3.65477667],
             [  1.16299807,   1.35088449,   2.49265488,   2.04226788,
               18.65538232],
             [  1.11059336,   1.2806907 ,   2.26371563,   1.88599305,
               10.61833194]])
```

48. Print the minimum and maximum representable value for each numpy scalar type ( )

```
[49]: print("Representable value of int:")
      for dtype in [np.int8, np.int32, np.int64]:
          print("min:",np.iinfo(dtype).min)
          print("max:",np.iinfo(dtype).max)
      print("Representable value of float:")
      for dtype in [np.float16, np.float32, np.float64]:
          print("min:",np.finfo(dtype).min)
          print("max:",np.finfo(dtype).max)
```

```
Representable value of int:
min: -128
max: 127
min: -2147483648
max: 2147483647
min: -9223372036854775808
max: 9223372036854775807
Representable value of float:
min: -65500.0
max: 65500.0
```

```
min: -3.4028235e+38
max: 3.4028235e+38
min: -1.7976931348623157e+308
max: 1.7976931348623157e+308
```

49. How to print all the values of an array? ( )

```python
[50]: np.set_printoptions(threshold=float("inf"))
      arr = np.zeros((5, 5))
      print(arr)
```

```
[[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.]]
```

50. How to find the closest value (to a given scalar) in a vector? ( )

```python
[51]: arr = np.arange(5)
      print(arr)
      rand_no = np.random.uniform(0,5)
      print(rand_no)
      i = (np.abs(arr-rand_no)).argmin()
      print(arr[i])
```

```
[0 1 2 3 4]
4.988150056681723
4
```

51. Create a structured array representing a position (x,y) and a color (r,g,b) ( )

```python
[52]: pos=[('x', float, 1),('y', float, 1)]
      col=[ ('r', float, 1),('g', float, 1),('b', float, 1)]
      arr= np.ones(5, [ ('position', pos),('color', col)])
      print(arr)
```

```
[((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.))]
```

```
c:\python\lib\site-packages\numpy\core\numeric.py:203: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  a = empty(shape, dtype, order)
```

52. Consider a random vector with shape (100,2) representing coordinates, find point by point distances ( )

```python
[53]: arr = np.random.random((100,2))
      dist=np.sqrt( (x-x.T)**2 + (y-y.T)**2)
      x,y = np.atleast_2d(arr[:,0],arr[:,1])
```

```
dist = np.sqrt( (x-x.T)**2 + (x-x.T)**2)
print(dist)
```

```
[[0.00000000e+00 9.95513112e-01 7.64387260e-02 2.15531506e-01
  1.13077353e+00 1.17210064e+00 6.21711869e-01 1.01532329e+00
  1.13198860e-01 6.21043583e-01 5.59632961e-01 1.84032405e-01
  6.65413184e-01 2.97599558e-01 6.91513287e-01 4.92206215e-01
  9.74731127e-02 5.97903142e-01 1.16505853e+00 1.32891983e-01
  5.86909772e-01 1.83893958e-01 1.06164882e+00 8.41993690e-01
  1.14527864e+00 1.10793699e+00 6.25490320e-03 7.74805532e-01
  1.81824666e-01 5.39782555e-02 2.47435166e-01 3.94743464e-01
  6.29359324e-01 7.64100363e-01 1.12185198e+00 6.07262619e-02
  4.94866218e-01 7.57213165e-01 8.70391237e-01 1.52165283e-01
  2.60148382e-01 3.16658744e-01 3.70946952e-01 1.06307250e+00
  5.98400828e-01 8.71457174e-01 8.09839338e-01 6.49443632e-01
  7.45148845e-01 7.48302029e-02 1.01843254e+00 1.75219863e-01
  1.54945766e-01 5.74598109e-01 1.94075385e-01 1.03209823e+00
  4.89980078e-01 3.69527026e-01 4.45306648e-01 1.15403627e+00
  7.04153502e-01 4.28892611e-02 6.21046133e-01 4.46814389e-01
  8.87707873e-01 7.13557901e-01 4.49374862e-02 1.71870457e-01
  5.90588777e-01 4.17505226e-01 1.54428763e-01 7.07600083e-01
  4.16475466e-01 9.65699531e-01 1.13192809e-01 5.65554768e-01
  9.81576312e-01 1.10602843e+00 1.04489985e+00 3.69014317e-01
  7.21975080e-01 2.09337062e-01 1.07085214e-01 5.63406394e-01
  1.14831190e-01 2.00333955e-01 8.10495391e-02 1.06128567e+00
  6.53082870e-02 1.21718302e-01 2.90847829e-01 1.75153901e-01
  9.47075609e-01 6.45767392e-01 4.15257716e-03 3.58243553e-01
  1.06940354e+00 9.32057527e-01 1.20077395e+00 1.11079657e+00]
 [9.95513112e-01 0.00000000e+00 1.07195184e+00 7.79981606e-01
  1.35260417e-01 1.76587532e-01 3.73801243e-01 1.98101735e-02
  1.10871197e+00 3.74469529e-01 4.35880151e-01 1.17954552e+00
  3.30099928e-01 6.97913554e-01 3.03999825e-01 5.03306897e-01
  1.09298622e+00 3.97609970e-01 1.69545419e-01 8.62621129e-01
  4.08603340e-01 1.17940707e+00 6.61357127e-02 1.53519422e-01
  1.49765525e-01 1.12423883e-01 1.00176802e+00 2.20707580e-01
  1.17733778e+00 1.04949137e+00 7.48077946e-01 6.00769648e-01
  3.66153788e-01 2.31412749e-01 1.26338869e-01 9.34786850e-01
  5.00646894e-01 2.38299947e-01 1.25121875e-01 8.43347829e-01
  7.35364730e-01 6.78854368e-01 6.24566160e-01 6.75593851e-02
  3.97112284e-01 1.24055938e-01 1.85673774e-01 3.46069480e-01
  2.50364267e-01 9.20682909e-01 2.29194273e-02 8.20293249e-01
  1.15045888e+00 4.20915004e-01 1.18958850e+00 3.65851221e-02
  5.05533035e-01 6.25986086e-01 5.50206464e-01 1.58523161e-01
  2.91359610e-01 1.03840237e+00 3.74466979e-01 5.48698724e-01
  1.07805239e-01 2.81955211e-01 9.50575626e-01 8.23642655e-01
  4.04924335e-01 5.78007886e-01 8.41084349e-01 2.87913029e-01
  5.79037646e-01 2.98135813e-02 1.10870592e+00 4.29958345e-01
  1.39368004e-02 1.10515316e-01 4.93867359e-02 6.26498796e-01
```

```
2.73538032e-01 7.86176050e-01 8.88427898e-01 4.32106718e-01
8.80681922e-01 7.95179157e-01 1.07656265e+00 6.57725623e-02
9.30204825e-01 8.73794810e-01 7.04665283e-01 8.20359211e-01
4.84375031e-02 3.49745720e-01 9.91360535e-01 6.37269559e-01
7.38904247e-02 6.34555847e-02 2.05260839e-01 1.15283458e-01]
[7.64387260e-02 1.07195184e+00 0.00000000e+00 2.91970232e-01
1.20721225e+00 1.24853937e+00 6.98150595e-01 1.09176201e+00
3.67601344e-02 6.97482309e-01 6.36071687e-01 1.07593679e-01
7.41851910e-01 3.74038284e-01 7.67952013e-01 5.68644941e-01
2.10343867e-02 6.74341868e-01 1.24149726e+00 2.09330709e-01
6.63348498e-01 1.07455232e-01 1.13808755e+00 9.18432416e-01
1.22171736e+00 1.18437572e+00 7.01838228e-02 8.51244258e-01
1.05385940e-01 2.24604705e-02 3.23873892e-01 4.71182190e-01
7.05798050e-01 8.40539089e-01 1.19829071e+00 1.37164988e-01
5.71304944e-01 8.33651891e-01 9.46829963e-01 2.28604009e-01
3.36587108e-01 3.93097470e-01 4.47385678e-01 1.13951122e+00
6.74839554e-01 9.47895900e-01 8.86278064e-01 7.25882358e-01
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7.80592228e-01 3.35494649e-02 6.97484859e-01 5.23253115e-01
9.64146599e-01 7.89996627e-01 1.21376212e-01 2.48309183e-01
6.67027503e-01 4.93943952e-01 2.30867489e-01 7.84038809e-01
4.92914192e-01 1.04213826e+00 3.67540830e-02 6.41993494e-01
1.05801504e+00 1.18246715e+00 1.12133857e+00 4.45453043e-01
7.98413806e-01 2.85775788e-01 1.83523940e-01 6.39845120e-01
1.91269916e-01 2.76772681e-01 4.61081306e-03 1.13772440e+00
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4.49881678e-01 8.20680521e-02 4.75981781e-01 2.76674709e-01
3.13004619e-01 3.82371636e-01 9.49527025e-01 8.26395230e-02
3.71378266e-01 3.99425464e-01 8.46117319e-01 6.26462184e-01
9.29747131e-01 8.92405489e-01 2.21786409e-01 5.59274026e-01
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2.79334712e-01 5.41681660e-01 6.54859731e-01 6.33662228e-02
4.46168764e-02 1.01127238e-01 1.55415446e-01 8.47540991e-01
3.82869322e-01 6.55925668e-01 5.94307832e-01 4.33912126e-01
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```

```
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  1.00700316e-01 1.51975505e-02 2.96581045e-01 8.45754168e-01
  1.50223219e-01 9.38132041e-02 7.53163228e-02 4.03776050e-02
  7.31544103e-01 4.30235886e-01 2.11378929e-01 1.42712047e-01
  8.53872031e-01 7.16526021e-01 9.85242445e-01 8.95265064e-01]
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  0.00000000e+00 4.13271153e-02 5.09061660e-01 1.15450243e-01
  1.24397239e+00 5.09729945e-01 5.71140568e-01 1.31480593e+00
  4.65360345e-01 8.33173971e-01 4.39260242e-01 6.38567313e-01
  1.22824664e+00 5.32870386e-01 3.42850022e-02 9.97881546e-01
  5.43863757e-01 1.31466749e+00 6.91247039e-02 2.88779839e-01
  1.45051079e-02 2.28365340e-02 1.13702843e+00 3.55967996e-01
  1.31259820e+00 1.18475178e+00 8.83338363e-01 7.36030064e-01
  5.01414204e-01 3.66673165e-01 8.92154777e-03 1.07004727e+00
  6.35907310e-01 3.73560363e-01 2.60382292e-01 9.78608246e-01
  8.70625146e-01 8.14114785e-01 7.59826577e-01 6.77010315e-02
  5.32372701e-01 2.59316355e-01 3.20934190e-01 4.81329897e-01
  3.85624684e-01 1.05594333e+00 1.12340989e-01 9.55553666e-01
  1.28571929e+00 5.56175420e-01 1.32484891e+00 9.86752945e-02
  6.40793451e-01 7.61246503e-01 6.85466881e-01 2.32627446e-02
  4.26620026e-01 1.17366279e+00 5.09727396e-01 6.83959140e-01
  2.43065655e-01 4.17215628e-01 1.08583604e+00 9.58903072e-01
  5.40184752e-01 7.13268303e-01 9.76344766e-01 4.23173445e-01
  7.14298062e-01 1.65073998e-01 1.24396634e+00 5.65218761e-01
  1.49197217e-01 2.47451007e-02 8.58736807e-02 7.61759212e-01
  4.08798449e-01 9.21436466e-01 1.02368831e+00 5.67367135e-01
  1.01594234e+00 9.30439573e-01 1.21182307e+00 6.94878543e-02
  1.06546524e+00 1.00905523e+00 8.39925700e-01 9.55619628e-01
  1.83697920e-01 4.85006137e-01 1.12662095e+00 7.72529975e-01
  6.13699919e-02 1.98716001e-01 7.00004226e-02 1.99769590e-02]
 [1.17210064e+00 1.76587532e-01 1.24853937e+00 9.56569138e-01
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  1.26957376e+00 5.74197502e-01 7.04211315e-03 1.03920866e+00
  5.85190872e-01 1.35599460e+00 1.10451819e-01 3.30106954e-01
  2.68220074e-02 6.41636493e-02 1.17835555e+00 3.97295112e-01
  1.35392531e+00 1.22607890e+00 9.24665478e-01 7.77357180e-01
  5.42741320e-01 4.08000281e-01 5.02486631e-02 1.11137438e+00
  6.77234426e-01 4.14887479e-01 3.01709407e-01 1.01993536e+00
  9.11952262e-01 8.55441900e-01 8.01153692e-01 1.09028147e-01
  5.73699816e-01 3.00643470e-01 3.62261306e-01 5.22657012e-01
  4.26951799e-01 1.09727044e+00 1.53668105e-01 9.96880781e-01
  1.32704641e+00 5.97502535e-01 1.36617603e+00 1.40002410e-01
  6.82120567e-01 8.02573618e-01 7.26793996e-01 1.80643707e-02
  4.67947142e-01 1.21498991e+00 5.51054511e-01 7.25286256e-01
```

2.84392771e-01 4.58542743e-01 1.12716316e+00 1.00023019e+00
5.81511867e-01 7.54595418e-01 1.01767188e+00 4.64500561e-01
7.55625178e-01 2.06401113e-01 1.28529345e+00 6.06545876e-01
1.90524332e-01 6.60722160e-02 1.27200796e-01 8.03086327e-01
4.50125564e-01 9.62763582e-01 1.06501543e+00 6.08694250e-01
1.05726945e+00 9.71766689e-01 1.25315018e+00 1.10814970e-01
1.10679236e+00 1.05038234e+00 8.81252815e-01 9.96946743e-01
2.25025035e-01 5.26333252e-01 1.16794807e+00 8.13857091e-01
1.02697107e-01 2.40043117e-01 2.86733073e-02 6.13040743e-02]
[6.21711869e-01 3.73801243e-01 6.98150595e-01 4.06180363e-01
5.09061660e-01 5.50388775e-01 0.00000000e+00 3.93611416e-01
7.34910729e-01 6.68285694e-04 6.20789085e-02 8.05744274e-01
4.37013147e-02 3.24112311e-01 6.98014178e-02 1.29505654e-01
7.19184982e-01 2.38087269e-02 5.43346662e-01 4.88819886e-01
3.48020974e-02 8.05605827e-01 4.39936956e-01 2.20281821e-01
5.23566768e-01 4.86225126e-01 6.27966772e-01 1.53093663e-01
8.03536535e-01 6.75690125e-01 3.74276703e-01 2.26968405e-01
7.64745515e-03 1.42388494e-01 5.00140112e-01 5.60985607e-01
1.26845651e-01 1.35501296e-01 2.48679368e-01 4.69546586e-01
3.61563487e-01 3.05053125e-01 2.50764917e-01 4.41360628e-01
2.33110413e-02 2.49745305e-01 1.88127469e-01 2.77317626e-02
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  6.52928070e-01 1.03704006e-01 1.18259635e+00 5.03848769e-01
  8.78272252e-02 3.66248912e-02 2.45036888e-02 7.00389220e-01
  3.47428457e-01 8.60066475e-01 9.62318323e-01 5.05997143e-01
  9.54572347e-01 8.69069581e-01 1.15045308e+00 8.11786246e-03
  1.00409525e+00 9.47685235e-01 7.78555708e-01 8.94249636e-01
  1.22327928e-01 4.23636145e-01 1.06525096e+00 7.11159983e-01
  0.00000000e+00 1.37346009e-01 1.31370414e-01 4.13930329e-02]
 [9.32057527e-01 6.34555847e-02 1.00849625e+00 7.16526021e-01
  1.98716001e-01 2.40043117e-01 3.10345658e-01 8.32657581e-02
  1.04525639e+00 3.11013944e-01 3.72424567e-01 1.11608993e+00
  2.66644344e-01 6.34457969e-01 2.40544241e-01 4.39851312e-01
  1.02953064e+00 3.34154385e-01 2.33001003e-01 7.99165544e-01
  3.45147756e-01 1.11595149e+00 1.29591297e-01 9.00638374e-02
  2.13221109e-01 1.75879467e-01 9.38312431e-01 1.57251995e-01
  1.11388219e+00 9.86035783e-01 6.84622362e-01 5.37314063e-01
  3.02698203e-01 1.67957164e-01 1.89794454e-01 8.71331265e-01
  4.37191309e-01 1.74844362e-01 6.16662904e-02 7.79892244e-01
  6.71909145e-01 6.15398783e-01 5.61110575e-01 1.31014970e-01
  3.33656700e-01 6.06003536e-02 1.22218189e-01 2.82613896e-01
  1.86908683e-01 8.57227325e-01 8.63750120e-02 7.56837664e-01
  1.08700329e+00 3.57459419e-01 1.12613291e+00 1.00040707e-01
  4.42077450e-01 5.62530501e-01 4.86750879e-01 2.21978746e-01
  2.27904025e-01 9.74946789e-01 3.11011395e-01 4.85243139e-01
  4.43496541e-02 2.18499626e-01 8.87120041e-01 7.60187070e-01
  3.41468750e-01 5.14552301e-01 7.77628765e-01 2.24457444e-01
  5.15582061e-01 3.36420034e-02 1.04525034e+00 3.66502760e-01
  4.95187842e-02 1.73970901e-01 1.12842321e-01 5.63043211e-01
```

```
 2.10082447e-01 7.22720465e-01 8.24972313e-01 3.68651134e-01
 8.17226338e-01 7.31723572e-01 1.01310707e+00 1.29228147e-01
 8.66749240e-01 8.10339226e-01 6.41209699e-01 7.56903626e-01
 1.50180815e-02 2.86290136e-01 9.27904950e-01 5.73813974e-01
 1.37346009e-01 0.00000000e+00 2.68716424e-01 1.78739042e-01]
[1.20077395e+00 2.05260839e-01 1.27721268e+00 9.85242445e-01
 7.00004226e-02 2.86733073e-02 5.79062082e-01 1.85450666e-01
 1.31397281e+00 5.79730368e-01 6.41140991e-01 1.38480636e+00
 5.35360768e-01 9.03174393e-01 5.09260664e-01 7.08567736e-01
 1.29824706e+00 6.02870809e-01 3.57154205e-02 1.06788197e+00
 6.13864180e-01 1.38466791e+00 1.39125127e-01 3.58780261e-01
 5.54953147e-02 9.28369566e-02 1.20702885e+00 4.25968419e-01
 1.38259862e+00 1.25475221e+00 9.53338786e-01 8.06030487e-01
 5.71414627e-01 4.36673588e-01 7.89219704e-02 1.14004769e+00
 7.05907733e-01 4.43560786e-01 3.30382714e-01 1.04860867e+00
 9.40625569e-01 8.84115207e-01 8.29826999e-01 1.37701454e-01
 6.02373124e-01 3.29316778e-01 3.90934613e-01 5.51330320e-01
 4.55625106e-01 1.12594375e+00 1.82341412e-01 1.02555409e+00
 1.35571972e+00 6.26175843e-01 1.39484934e+00 1.68675717e-01
 7.10793874e-01 8.31246925e-01 7.55467303e-01 4.67376780e-02
 4.96620449e-01 1.24366321e+00 5.79727818e-01 7.53959563e-01
 3.13066078e-01 4.87216050e-01 1.15583647e+00 1.02890349e+00
 6.10185174e-01 7.83268725e-01 1.04634519e+00 4.93173868e-01
 7.84298485e-01 2.35074421e-01 1.31396676e+00 6.35219184e-01
 2.19197640e-01 9.47455233e-02 1.55874103e-01 8.31759635e-01
 4.78798871e-01 9.91436889e-01 1.09368874e+00 6.37367558e-01
 1.08594276e+00 1.00044000e+00 1.28182349e+00 1.39488277e-01
 1.13546566e+00 1.07905565e+00 9.09926123e-01 1.02562005e+00
 2.53698342e-01 5.55006560e-01 1.19662137e+00 8.42530398e-01
 1.31370414e-01 2.68716424e-01 0.00000000e+00 8.99773816e-02]
[1.11079657e+00 1.15283458e-01 1.18723530e+00 8.95265064e-01
 1.99769590e-02 6.13040743e-02 4.89084701e-01 9.54732841e-02
 1.22399543e+00 4.89752986e-01 5.51163609e-01 1.29482898e+00
 4.45383386e-01 8.13197012e-01 4.19283283e-01 6.18590354e-01
 1.20826968e+00 5.12893427e-01 5.42619612e-02 9.77904587e-01
 5.23886798e-01 1.29469053e+00 4.91477449e-02 2.68802880e-01
 3.44820669e-02 2.85957497e-03 1.11705147e+00 3.35991037e-01
 1.29262124e+00 1.16477483e+00 8.63361404e-01 7.16053105e-01
 4.81437245e-01 3.46696206e-01 1.10554112e-02 1.05007031e+00
 6.15930351e-01 3.53583404e-01 2.40405333e-01 9.58631287e-01
 8.50648187e-01 7.94137826e-01 7.39849618e-01 4.77240725e-02
 5.12395742e-01 2.39339396e-01 3.00957231e-01 4.61352938e-01
 3.65647725e-01 1.03596637e+00 9.23640303e-02 9.35576707e-01
 1.26574234e+00 5.36198461e-01 1.30487195e+00 7.86983355e-02
 6.20816492e-01 7.41269544e-01 6.65489922e-01 4.32397036e-02
 4.06643067e-01 1.15368583e+00 4.89750437e-01 6.63982181e-01
 2.23088696e-01 3.97238669e-01 1.06585908e+00 9.38926113e-01
 5.20207793e-01 6.93291344e-01 9.56367807e-01 4.03196486e-01
```

```
6.94321103e-01 1.45097039e-01 1.22398938e+00 5.45241802e-01
1.29220258e-01 4.76814165e-03 6.58967217e-02 7.41782253e-01
3.88821489e-01 9.01459507e-01 1.00371136e+00 5.47390176e-01
9.95965380e-01 9.10462614e-01 1.19184611e+00 4.95108953e-02
1.04548828e+00 9.89078268e-01 8.19948741e-01 9.35642669e-01
1.63720961e-01 4.65029178e-01 1.10664399e+00 7.52553016e-01
4.13930329e-02 1.78739042e-01 8.99773816e-02 0.00000000e+00]]
```

53. How to convert a float (32 bits) array into an integer (32 bits) in place?

```
[54]: arr = np.arange(10, dtype=np.float32)
      arr = arr.astype(np.int32)
      print(arr)
```

```
[0 1 2 3 4 5 6 7 8 9]
```

54. How to read the following file? ( )

```
1, 2, 3, 4, 5
6,  ,  , 7, 8
 ,  , 9,10,11
```

```
[55]: #arr = np.genfromtxt("file.dat", delimiter=",")
```

55. What is the equivalent of enumerate for numpy arrays? ( )

```
[56]: arr = np.random.random((10,2))
      for index, value in np.ndenumerate(arr):
          print(index, value)
```

```
(0, 0) 0.006470462632010565
(0, 1) 0.58571971124948
(1, 0) 0.9893931631773392
(1, 1) 0.1600427233682985
(2, 0) 0.899946868617869
(2, 1) 0.12839097548288614
(3, 0) 0.2812771351417309
(3, 1) 0.07310009359744296
(4, 0) 0.8372381235759075
(4, 1) 0.4719807763283981
(5, 0) 0.6681657334256131
(5, 1) 0.33428732763173774
(6, 0) 0.7477390986886869
(6, 1) 0.7094716436672652
(7, 0) 0.7275695317181106
(7, 1) 0.08758008995843236
(8, 0) 0.8344623893250117
(8, 1) 0.3052946211021954
(9, 0) 0.8433587297189313
(9, 1) 0.35942426494158675
```

56. Generate a generic 2D Gaussian-like array ( )

```
[57]: sig=1.0
      mu=0.0
      x, y = np.meshgrid(np.linspace(-1,1,10), np.linspace(-1,1,10))
      d = np.sqrt(x**2+y**2)
      D_G = np.exp(-( (d-mu)**2 / ( 2.0 * sig**2 ) ) )
      print(D_G)
```

```
[[0.36787944 0.44822088 0.51979489 0.57375342 0.60279818 0.60279818
  0.57375342 0.51979489 0.44822088 0.36787944]
 [0.44822088 0.54610814 0.63331324 0.69905581 0.73444367 0.73444367
  0.69905581 0.63331324 0.54610814 0.44822088]
 [0.51979489 0.63331324 0.73444367 0.81068432 0.85172308 0.85172308
  0.81068432 0.73444367 0.63331324 0.51979489]
 [0.57375342 0.69905581 0.81068432 0.89483932 0.9401382  0.9401382
  0.89483932 0.81068432 0.69905581 0.57375342]
 [0.60279818 0.73444367 0.85172308 0.9401382  0.98773022 0.98773022
  0.9401382  0.85172308 0.73444367 0.60279818]
 [0.60279818 0.73444367 0.85172308 0.9401382  0.98773022 0.98773022
  0.9401382  0.85172308 0.73444367 0.60279818]
 [0.57375342 0.69905581 0.81068432 0.89483932 0.9401382  0.9401382
  0.89483932 0.81068432 0.69905581 0.57375342]
 [0.51979489 0.63331324 0.73444367 0.81068432 0.85172308 0.85172308
  0.81068432 0.73444367 0.63331324 0.51979489]
 [0.44822088 0.54610814 0.63331324 0.69905581 0.73444367 0.73444367
  0.69905581 0.63331324 0.54610814 0.44822088]
 [0.36787944 0.44822088 0.51979489 0.57375342 0.60279818 0.60279818
  0.57375342 0.51979489 0.44822088 0.36787944]]
```

57. How to randomly place p elements in a 2D array? ( )

```
[58]: n = 5
      p = 4
      arr = np.zeros((n,n))
      coice_= np.random.choice(n*n, p)
      np.put(arr, coice_ ,1)
      print (arr)
```

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

58. Subtract the mean of each row of a matrix ( )

```
[59]: arr = np.random.rand(5, 10)
      arr_mean=np.mean(arr,axis=1,keepdims=True)
      arr_n =arr - arr_mean
```

```
print(arr_n)
```

```
[[-0.18278887 -0.0829295  -0.1163292  -0.1560689   0.34680445  0.37962282
  -0.09341057 -0.36021401  0.16957714  0.09573664]
 [ 0.3115932  -0.15454836  0.00093557  0.53952301 -0.42604672 -0.21578636
  -0.26126647  0.19383805 -0.07330451  0.08506258]
 [ 0.38812039 -0.29025457 -0.41582001 -0.17110055 -0.32243043  0.01978453
  -0.14104297  0.5623066   0.14681052  0.22362649]
 [ 0.30449831  0.04526903  0.18709459  0.43244215 -0.42049537 -0.15080337
   0.16107828 -0.18170576 -0.13599123 -0.24138662]
 [-0.26770262 -0.27499858 -0.06171656  0.24335376 -0.2097737   0.57010262
   0.49869769 -0.2613587  -0.22101166 -0.01559225]]
```

59. How to sort an array by the nth column? ( )

[60]:
```
n_col=1
arr = np.random.randint(0,16,(4,4))
print(arr)
col_arr=arr[:,n_col].argsort()
print(arr[col_arr])
```

```
[[15 13  0  9]
 [ 9 14 14 14]
 [15 10  8 10]
 [ 4 10  8 11]]
[[15 10  8 10]
 [ 4 10  8 11]
 [15 13  0  9]
 [ 9 14 14 14]]
```

60. How to tell if a given 2D array has null columns? ( )

[61]:
```
arr = np.random.randint(0,3,(3,10))
print((~arr.any(axis=0)).any())
```

```
False
```

61. Find the nearest value from a given value in an array ( )

[62]:
```
arr = np.random.uniform(0,1,10)
print(arr)
given = 0.4
i = (np.abs(arr-given)).argmin()
print(arr[i])
```

```
[0.10127578 0.36606584 0.36791585 0.15245    0.96887637 0.00994273
 0.49128907 0.45917014 0.14580695 0.95668768]
0.3679158481788354
```

62. Considering two arrays with shape (1,3) and (3,1), how to compute their sum using an iterator? ( )

```
[ ]:
```

63. Create an array class that has a name attribute ( )

```
[63]: class name_arr(np.ndarray):
          def __new__(cls, array, name="no name"):
              obj = np.asarray(array).view(cls)
              obj.name = name
              return obj

      arr = name_arr(np.arange(10), "Hello")
      print (arr.name)
```

```
Hello
```

64. Consider a given vector, how to add 1 to each element indexed by a second vector (be careful with repeated indices)? ( )

```
[64]: arr = np.ones(10)
      where = np.random.randint(0,len(arr),10)
      np.add.at(arr, where, 1)
      print(arr)
```

```
[4. 3. 1. 2. 1. 3. 2. 2. 1. 1.]
```

65. How to accumulate elements of a vector (X) to an array (F) based on an index list (I)? ( )

```
[65]: vec = np.random.randint(0,15,10)
      in_list = np.random.randint(0,15,10)
      arr = np.bincount(in_list,vec)
      print(arr)
```

```
[ 0. 16.  0. 13. 14. 14. 11.  0.  0.  0.  1.  0.  0. 12.]
```

66. Considering a (w,h,3) image of (dtype=ubyte), compute the number of unique colors ( )

```
[ ]:
```

67. Considering a four dimensions array, how to get sum over the last two axis at once? ( )

```
[66]: arr = np.random.randint(0,10,(4,4,4,4))
      # solution by passing a tuple of axes (introduced in numpy 1.7.0)
      sum_ = arr.sum(axis=(-2,-1))
      print(sum_)
```

```
[[ 52  88  77  69]
 [ 69  61  76  68]
 [103  87  68  84]
 [ 74  87  69  90]]
```

68. Considering a one-dimensional vector D, how to compute means of subsets of D using a vector S of same size describing subset indices? ( )

[ ]:

69. How to get the diagonal of a dot product? ( )

[67]:
```python
arr_1 = np.random.random((5,5))
arr_2 = np.random.random((5,5))
print(np.diag(np.dot(arr_1, arr_2)))
```

```
[1.4166591  0.53529397 1.03702956 0.87805152 1.03134601]
```

70. Consider the vector [1, 2, 3, 4, 5], how to build a new vector with 3 consecutive zeros interleaved between each value? ( )

[68]:
```python
arr = np.array([1,2,3,4,5])
with_0 = np.zeros(len(arr) + (len(arr)-1)*(3))
with_0[::3+1] = arr
print(with_0)
```

```
[1. 0. 0. 0. 2. 0. 0. 0. 3. 0. 0. 0. 4. 0. 0. 0. 5.]
```

71. Consider an array of dimension (5,5,3), how to mulitply it by an array with dimensions (5,5)? ( )

[69]:
```python
arr1 = np.random.random((5,5,3))
arr2 = np.random.random((5,5))
arr1 * arr2[:,:,None]
```

[69]:
```
array([[[4.17414810e-01, 3.93634679e-01, 3.61671402e-01],
        [3.49483857e-01, 1.10893480e-02, 2.89812181e-01],
        [8.51323705e-01, 1.57268361e-01, 6.67734792e-01],
        [4.14440219e-01, 7.26053843e-02, 4.07246426e-01],
        [1.41174570e-02, 7.16539756e-02, 6.06297713e-02]],

       [[4.42728750e-02, 7.96998546e-02, 2.96100347e-02],
        [5.27226499e-01, 2.21934095e-01, 1.60146815e-01],
        [7.65054029e-01, 7.76982724e-02, 1.82695358e-01],
        [3.12056289e-01, 6.12004699e-01, 1.42085300e-03],
        [4.77578655e-02, 1.53934474e-01, 1.18475620e-01]],

       [[5.20574785e-01, 1.22991941e-01, 2.47519507e-01],
        [2.10431521e-01, 1.54215558e-01, 6.84183108e-03],
        [4.72815270e-01, 4.42434593e-02, 5.65804881e-01],
        [1.70003835e-01, 5.21088924e-01, 2.81988241e-01],
        [8.49854814e-02, 1.91108656e-01, 1.97700641e-01]],

       [[2.28673048e-01, 1.45613521e-01, 1.68971915e-01],
        [1.85489786e-01, 4.60464336e-01, 1.02705802e-02],
        [1.77714502e-01, 5.18525199e-01, 1.40631971e-01],
```

```
         [1.38214965e-01, 3.26172743e-01, 3.31533751e-01],
         [2.35481016e-01, 1.63762122e-02, 2.96893671e-02]],


        [[1.05240924e-01, 2.18245263e-01, 4.92353842e-02],
         [4.81762031e-02, 3.21978085e-02, 2.85683695e-02],
         [6.60760958e-01, 4.59272218e-01, 1.59569485e-01],
         [5.37492755e-01, 1.48848817e-01, 3.47054316e-01],
         [7.16286690e-04, 5.53336287e-03, 7.24506382e-03]]])
```

72. How to swap two rows of an array? ( )

```
[70]: arr = np.random.random((3,3))
      print(arr)
      row_1=0
      row_2=2
      arr[[row_1,row_2]] = arr[[row_2,row_1]]
      print(arr)
```

```
[[0.04107831 0.73213293 0.60962514]
 [0.38226261 0.38771327 0.75926853]
 [0.64396577 0.16802357 0.84726752]]
[[0.64396577 0.16802357 0.84726752]
 [0.38226261 0.38771327 0.75926853]
 [0.04107831 0.73213293 0.60962514]]
```

73. Consider a set of 10 triplets describing 10 triangles (with shared vertices), find the set of unique line segments composing all the triangles ( )

```
[ ]:
```

74. Given a sorted array C that corresponds to a bincount, how to produce an array A such that np.bincount(A) == C? ( )

```
[71]: arr=np.random.randint(0,10,10)
      C = np.bincount(arr)
      A = np.repeat(np.arange(len(C)), C)
      print(C)
      print(A)
```

```
[0 1 0 2 0 1 2 0 3 1]
[1 3 3 5 6 6 8 8 8 9]
```

75. How to compute averages using a sliding window over an array? ( )

```
[ ]:
```

76. Consider a one-dimensional array Z, build a two-dimensional array whose first row is (Z[0],Z[1],Z[2]) and each subsequent row is shifted by 1 (last row should be (Z[-3],Z[-2],Z[-1]) ( )

```
[ ]:
```

77. How to negate a boolean, or to change the sign of a float inplace? ( )

```
[72]: arr = np.random.randint(0,2,10)
      print(np.bool_(arr))
      print(~np.bool_(arr))
      arr = np.random.uniform(-1.0,1.0,10)
      print(arr)
      print(np.negative(arr))
```

```
[ True  True False False  True False False False  True  True]
[False False  True  True False  True  True  True False False]
[-0.26986278 -0.03948178 -0.91752429  0.83938343  0.71729349 -0.1836054
 -0.01916628 -0.59583897  0.86337679 -0.14949759]
[ 0.26986278  0.03948178  0.91752429 -0.83938343 -0.71729349  0.1836054
  0.01916628  0.59583897 -0.86337679  0.14949759]
```

78. Consider 2 sets of points P0,P1 describing lines (2d) and a point p, how to compute distance from p to each line i (P0[i],P1[i])? ( )

`[ ]:`

79. Consider 2 sets of points P0,P1 describing lines (2d) and a set of points P, how to compute distance from each point j (P[j]) to each line i (P0[i],P1[i])? ( )

`[ ]:`

80. Consider an arbitrary array, write a function that extract a subpart with a fixed shape and centered on a given element (pad with a `fill` value when necessary) ( )

`[ ]:`

81. Consider an array Z = [1,2,3,4,5,6,7,8,9,10,11,12,13,14], how to generate an array R = [[1,2,3,4], [2,3,4,5], [3,4,5,6], ..., [11,12,13,14]]? ( )

```
[73]: arr = np.arange(1,15,dtype=int)
      arr = np.lib.stride_tricks.as_strided(arr,(11,4),(4,4))
      print(arr)
```

```
[[ 1  2  3  4]
 [ 2  3  4  5]
 [ 3  4  5  6]
 [ 4  5  6  7]
 [ 5  6  7  8]
 [ 6  7  8  9]
 [ 7  8  9 10]
 [ 8  9 10 11]
 [ 9 10 11 12]
 [10 11 12 13]
 [11 12 13 14]]
```

82. Compute a matrix rank ( )

```
[ ]:
```

83. How to find the most frequent value in an array?

```
[74]: arr = np.random.randint(0,5,10)
      print(arr)
      print(np.bincount(arr).argmax())
```

```
[2 4 4 4 3 0 4 3 0 3]
4
```

84. Extract all the contiguous 3x3 blocks from a random 10x10 matrix ( )

```
[ ]:
```

85. Create a 2D array subclass such that Z[i,j] == Z[j,i] ( )

```
[ ]:
```

86. Consider a set of p matrices wich shape (n,n) and a set of p vectors with shape (n,1). How to compute the sum of of the p matrix products at once? (result has shape (n,1)) ( )

```
[ ]:
```

87. Consider a 16x16 array, how to get the block-sum (block size is 4x4)? ( )

```
[ ]:
```

88. How to implement the Game of Life using numpy arrays? ( )

```
[ ]:
```

89. How to get the n largest values of an array ( )

```
[75]: arr = np.random.randint(0,50,50)
      n = 5
      sort_index=np.argsort(arr)
      print(arr)
      print(sort_index)
      sort_arr = arr[sort_index]
      print(sort_arr)
      reslt = sort_arr[-n : ]
      print(reslt)
```

```
[ 2 49 41 24 26 25 47 21 11 22 39  3 28 37  9 20 44 22 19 16 48 24  9 10
   6  7 39 48 24 48 11 21 38 44 33 31 14  5 41  0 37 37 29 48 37  8 41  0
  17 34]
[47 39  0 11 37 24 25 45 22 14 23 30  8 36 19 48 18 15  7 31 17  9 21  3
  28  5  4 12 42 35 34 49 13 40 41 44 32 10 26 46 38  2 33 16  6 29 20 43
  27  1]
[ 0  0  2  3  5  6  7  8  9  9 10 11 11 14 16 17 19 20 21 21 22 22 24 24
  24 25 26 28 29 31 33 34 37 37 37 37 38 39 39 41 41 41 44 44 47 48 48 48
```

```
 48 49]
[48 48 48 48 49]
```

90. Given an arbitrary number of vectors, build the cartesian product (every combinations of every item) ( )

[ ]:

91. How to create a record array from a regular array? ( )

```
[76]: arr = np.array([(4,9.61,"Machine"),
                      (7,2.46,"Learning")])
      record = np.core.records.fromarrays(arr.T,names='col_1, col_2, col_3',formats =␣
       ↪'i, f, S8')
      print(record)
```

```
[(4, 9.61, b'Machine') (7, 2.46, b'Learning')]
```

92. Consider a large vector Z, compute Z to the power of 3 using 3 different methods ( )

```
[77]: x = np.random.rand(5**7)
      re_1=np.power(x,3)
      re_2=x**3
```

93. Consider two arrays A and B of shape (8,3) and (2,2). How to find rows of A that contain elements of each row of B regardless of the order of the elements in B? ( )

[ ]:

94. Considering a 10x3 matrix, extract rows with unequal values (e.g. [2,2,3]) ( )

```
[78]: arr = np.random.randint(0,2,(10,3))
      arr_ = np.all(arr[:,1:] == arr[:,:-1], axis=1)
      unequal = arr[~arr_]
      print(unequal)
```

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

95. Convert a vector of ints into a matrix binary representation ( )

[ ]:

96. Given a two dimensional array, how to extract unique rows? ( )

```
[79]: arr = np.random.randint(0,2,(10,2))
      print(arr)
```

```
unique = np.unique(arr, axis=0)
print(unique)
```

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

97. Considering 2 vectors A & B, write the einsum equivalent of inner, outer, sum, and mul function ( )

```
[80]: arr_1 = np.random.uniform(0,1,5)
      arr_2 = np.random.uniform(0,1,5)
      print(np.einsum('i->', arr_1))
      print(np.einsum('i,i->i', arr_1, arr_2))
      print(np.einsum('i,i', arr_1, arr_2))
      print(np.einsum('i,j->ij', arr_1, arr_2))
```

```
1.944057819381744
[0.61937843 0.07686733 0.05163617 0.58707157 0.07148268]
1.4064361793423703
[[0.61937843 0.64774149 0.56740174 0.68531533 0.14245191]
 [0.07350149 0.07686733 0.06733343 0.08132621 0.01690473]
 [0.05636629 0.05894746 0.05163617 0.06236685 0.01296378]
 [0.53058709 0.55488414 0.48606154 0.58707157 0.12203063]
 [0.31080545 0.32503809 0.28472343 0.34389273 0.07148268]]
```

98. Considering a path described by two vectors (X,Y), how to sample it using equidistant samples ( )?

```
[ ]:
```

99. Given an integer n and a 2D array X, select from X the rows which can be interpreted as draws from a multinomial distribution with n degrees, i.e., the rows which only contain integers and which sum to n. ( )

```
[82]: arr = np.random.randint(0,3,(10,3))
      print(arr)
      n = 3
      M = np.logical_and.reduce(np.mod(arr, 1) == 0, axis=-1)
```

```
M &= (arr.sum(axis=-1) == n)
print(arr[M])
```

```
[[2 1 0]
 [2 2 0]
 [1 1 0]
 [0 2 1]
 [1 0 0]
 [2 0 2]
 [2 1 0]
 [1 0 1]
 [2 1 0]
 [0 0 1]]
[[2 1 0]
 [0 2 1]
 [2 1 0]
 [2 1 0]]
```

100. Compute bootstrapped 95% confidence intervals for the mean of a 1D array X (i.e., resample the elements of an array with replacement N times, compute the mean of each sample, and then compute percentiles over the means). ( )

[ ]: