

## Numpy

### **Part 1 - basic**

Please solve the following exercises  
Good Luck!

1. Import the numpy package under the name `np`
2. Print the numpy version  
hint: search on Google "numpy version", the first entry.
3. Create a vector of zeros with the size 10  
hint: use np.zeros()
4. How to find the memory size of any array  
hint: itemsize returns the size in memory of each element
5. How to get the documentation of the numpy add function from the IPython console?  
hint: try "?" before the function name
6. Create a vector of zeros with the size 10 but the fifth value which is 1
7. Create a vector with values ranging from 10 to 49 (★☆☆)  
hint: arange
8. Reverse a vector (first element becomes last) (★☆☆)  
hint:[::-1]
9. Create a 3x3 matrix with values ranging from 0 to 8 (★☆☆)  
hint: reshape
10. Find indices of non-zero elements from \[1,2,0,0,4,0\] (★☆☆)  
hint: nonzero
11. Create a 3x3 identity matrix (★☆☆)  
hint: the best numpy documentation is in the scipy website :)  
try <https://docs.scipy.org/doc/numpy/reference/generated/numpy.eye.html>

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

hint: <https://docs.scipy.org/doc/numpy/reference/routines.random.html>

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

hint: a.min,a.max

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

hint: a.mean

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

hint: ones()

hint2: for an array a, which elements are chosen by a[1:-1] ?

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

hint: <https://docs.scipy.org/doc/numpy/reference/generated/numpy.pad.html>

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

```
```python
0 * np.nan
np.nan == np.nan
np.inf > np.nan
np.nan - np.nan
0.3 == 3 * 0.1
```
```

hint 1: nan is not a number

hint 2: try printing the expressions to see what is printed

18. Create a 5x5 matrix with values 1,2,3,4,7 on the diagonal

hint: np.diag

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

hint1: slicing an array you can use - list[start:end:step]

hint2: [::2] - for even. [1::2] - for odd

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

hint: [https://docs.scipy.org/doc/numpy-1.10.0/reference/generated/numpy.unravel\\_index.html](https://docs.scipy.org/doc/numpy-1.10.0/reference/generated/numpy.unravel_index.html)

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

hint: numpy.tile(A, reps)

Construct an array by repeating A the number of times given by reps.

22. Normalize a 5x5 random matrix

hint: create a random 5\*5 matrix

subtract the min value, then divide by (max-min)

23. Create an array of 2x4 with dtype numpy.int16, print the dtype of the array (RGBA)

24. Multiply a 5x3 matrix by a 3x2 matrix (real matrix product)  
hint: numpy.dot()

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

answer:

```
Z = np.arange(11)
Z[(3 < Z) & (Z <= 8)] *= -1
print(Z)
```

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

```
```python
Author: Jake VanderPlas

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

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

```
```python
Z**Z
Z <- Z
1j*Z
```
```

28. What are the result of the following expressions?

```
```python
np.array(0) / np.array(0)
np.array(0) // np.array(0)
```
```

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

hint:

```
1.numpy.copysign
2.numpy.ceil
```

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

hint: <https://docs.scipy.org/doc/numpy/reference/generated/numpy.intersect1d.html>

The exercises from here on are for advanced students:

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

hint: <https://docs.scipy.org/doc/numpy/reference/generated/numpy.seterr.html>

32. Is the following expressions true? (★☆☆)

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

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

hint:

```
yesterday = np.datetime64('today', 'D') - np.timedelta64(1, 'D')
```

now calculate today and tomorrow:

34. How to get all the dates corresponding to the month of August 2016?

hint: This is the answer for July

```
Z = np.arange('2016-07', '2016-08', dtype='datetime64[D]')
```

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

36. Extract the integer part of a random array using 5 different methods

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

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

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

## **part 2 - advanced**

41. Print the minimum and maximum representable value for each numpy scalar type (★★☆)
42. How to print all the values of an array? (★★☆)
43. How to find the closest value (to a given scalar) in an array? (★★☆)
44. Create a structured array representing a position (x,y) and a color (r,g,b) (★★☆)
45. Consider a random vector with shape (100,2) representing coordinates, find point by point distances (★★☆)
46. How to convert a float (32 bits) array into an integer (32 bits) in place?
47. How to read the following file? (★★☆)
48. What is the equivalent of *enumerate* for numpy arrays? (★★☆)
49. Generate a generic 2D Gaussian-like array (★★☆)
50. How to randomly place p elements in a 2D array? (★★☆)
51. Subtract the mean of each row of a matrix (★★☆)
52. How to I sort an array by the nth column? (★★☆)
53. How to tell if a given 2D array has null columns? (★★☆)
54. Find the nearest value from a given value in an array (★★☆)
55. Create an array class that has a *name* attribute (★★☆)
56. Consider a given vector, how to add 1 to each element indexed by a second vector (be careful with repeated indices)? (★★★)
57. How to accumulate elements of a vector (X) to an array (F) based on an index list (I)? (★★★)
58. Considering a (w,h,3) image of (dtype=ubyte), compute the number of unique colors (★★★)
59. Considering a four dimensions array, how to get sum over the last two axis at once? (★★★)
60. Considering a one-dimensional vector D, how to compute means of subsets of D using a vector S of same size describing subset indices? (★★★)
61. How to get the diagonal of a dot product? (★★★)
62. Consider the vector [1, 2, 3, 4, 5], how to build a new vector with 3 consecutive zeros interleaved between each value? (★★★)
63. Consider an array of dimension (5,5,3), how to multiply it by an array with dimensions (5,5)? (★★★)
64. How to swap two rows of an array? (★★★)

65. Consider a set of 10 triplets describing 10 triangles (with shared vertices), find the set of unique line segments composing all the triangles (★★★)
66. Given an array C that is a bincount, how to produce an array A such that `np.bincount(A) == C`? (★★★)
67. How to compute averages using a sliding window over an array? (★★★)
68. 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])) (★★★)
69. How to negate a boolean, or to change the sign of a float inplace? (★★★)
70. 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])? (★★★)
71. 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])? (★★★)
72. 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) (★★★)
73. 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]]`? (★★★)
74. Compute a matrix rank (★★★)
75. How to find the most frequent value in an array?
76. Extract all the contiguous 3x3 blocks from a random 10x10 matrix (★★★)
77. Create a 2D array subclass such that `Z[i,j] == Z[j,i]` (★★★)
78. Consider a set of p matrices with shape (n,n) and a set of p vectors with shape (n,1). How to compute the sum of the p matrix products at once? (result has shape (n,1)) (★★★)
79. Consider a 16x16 array, how to get the block-sum (block size is 4x4)? (★★★)
80. How to implement the Game of Life using numpy arrays? (★★★)
81. How to get the n largest values of an array (★★★)
82. Given an arbitrary number of vectors, build the cartesian product (every combinations of every item) (★★★)
83. How to create a record array from a regular array? (★★★)
84. Consider a large vector Z, compute Z to the power of 3 using 3 different methods (★★★)
85. 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? (★★★)
86. Considering a 10x3 matrix, extract rows with unequal values (e.g. [2,2,3]) (★★★)
87. Convert a vector of ints into a matrix binary representation (★★★)

88. Given a two dimensional array, how to extract unique rows? (★★★)
89. Considering 2 vectors A & B, write the einsum equivalent of inner, outer, sum, and mul function (★★★)
90. Considering a path described by two vectors (X,Y), how to sample it using equidistant samples (★★★)?
91. 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. (★★★)