NUMPY

If you are more interested in mathematics or want to gain more skills in numpy, I strongly recommend you to do exercises below. You might find it much more difficult than earlier, but don't give up!!!

For all exercises below, firstly think how would you do it without numpy built-in functions. Then, use provided documentation link or other resources to find numpy facilities. Implement it on your examples, even if it's not said to do that.

Again, we need to create Jupiter file, save it, import relevant libraries.

1. First contact with arrays.
   1.1 Create new vector: [6, 8, -2, 13, 1, -7, 9]. Indicate its length, find its biggest value, calculate mean, variance, standard deviation, replace all negative numbers by 0 and sort the array.
   1.2 Add two vectors together. Is it different than addition + in normal python?

2. Create structured array. You may need to use this link. Can you do it in MatLab as well?

3. Do something new!
   3.1. Implement the function for finding n largest values of the array.
   3.2. Take the vector of integers and change it to two-dimensional matrix binary representation.

4. Again, matrices!! Create new matrices - 3x3 identity matrix, the one with values [0..8] and your 3x5 favourite matrix.
   4.1 Perform multiplication to obtain new ones.
   4.2 Did you use dot or matmul? What is the difference?
   4.3 Check how to obtain the determinant and inverse of given matrix.
   4.4 Find its eigenstuff (eigenvalues, and corresponding eigenvectors).
   Note: Use linalg.
5. How to do element-wise operations? What about in place operations? Practise it:
   5.1 Normalize 5x5 matrix.
   5.2 All integers to float
   5.3 * Perform gaussian elimination
   5.4 Swap two rows.

6. Random in numpy.
   6.1 Create new 3x3 with random values.
   6.2 Randomly place p elements in matrix.

7. More linear algebra..
   7.1 Which row are null?
   7.2 Extract unique columns(not being linear combination of others)
   7.3 What is the rank of a matrix?
   7.4 Indicate null columns.

8.* This one is more challenging. It is about LU, LUP, LDU decompositions.

Firstly recall, upper triangular (and in similar way lower) matrix has all entries below the main diagonal equal to zero. There is the theorem that every invertible matrix can be represented as product of LU or LPU or LDU, where P is permutation and D diagonal matrix. From mathematical point of view, we can use Doolittle's Method for LU Decompositions.

Why??? For computer scientists it's extremely important. Matrices help us to represent and find the solutions for systems of linear equations. Computers solve it with decompositions!

With this link, you can try to do LU decomposition on your own. Use this link if you stuck or you need extra inspiration.

Use numpy to automatically find matrix decomposition (linalg library).