

EN2550 Homework 1 on Python and NumPy

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1. Write a program to display the squares of numbers from 1 to 5 as seen below.

```
1 : 1
2 : 4
3 : 9
4 : 16
5 : 25
```

2. Alter the code in [14](#) to print the square only of non-prime numbers. Use the `isprime` function in the `sympy` package for testing if a number is a prime.
3. Use a comprehension to do [14](#).
4. Use a comprehension to do [11](#).
5. Using NumPy carry out the following computations.

(a) Matric multiplication

$$C = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix} \times \begin{bmatrix} 7 & 8 & 9 & 1 \\ 1 & 2 & 3 & 4 \end{bmatrix}.$$

(b) Element-wise multiply

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix} \text{ and } B = \begin{bmatrix} 3 & 2 \\ 5 & 4 \\ 3 & 1 \end{bmatrix}.$$

6. Generate a 5×7 array of random integers in the interval $[0, 10]$ and extract the sub array consisting rows 2 to 4 and columns 1 and first two columns. What is the size of the resulting array?
7. Show three examples of broadcasting.
8. Consider the following code snippet

```

m, c = 2, -4
N = 10
x = np.linspace(0, N-1, N).reshape(N,1)
sigma = 10
y = m*x + c + np.random.normal(0, sigma, (N,1))

```

- (a) Append a column of ones to x to create \mathbf{X} .
 - (b) Compute $[\mathbf{X}^T \mathbf{X}]^{-1} \mathbf{X}^T y$
9. (Advanced, optional) Write a function that computes the square root of a given number by
- (a) Computing the hyperbolic estimate of the square root as the initial guess. I.e., for $S = a \times 10^{2n}$ where $a \in [1, 100]$ ¹

$$\sqrt{S} \approx \left(\frac{-190}{a+20} + 10 \right) \times 10^n.$$
 - (b) Using this initial estimate as s_0 use Newton-Raphson method² to find the square root with a given precision (e.g., 10^{-5})
 - (c) Compute the square root of 64, 75, 100, and 1600.
10. Use Gaussian smoothing to filter the noise in the image gal_gaussian.png shown in Fig. 1³.



Figure 1: Image corrupted with Gaussian noise

- 11. Use median filtering to filter the salt and pepper noise in the image gal_sandp.png shown in Fig. 2.
- 12. Create a 40×60 grayscale image and change the color of the top-right quarter to 125.
- 13. Create a 40×60 color image and change the color of the bottom-left quarter to “Barbie Pink”⁴.
- 14. Increase the brightness of the image tom_dark.jpg shown in Fig. 3.

¹https://en.wikipedia.org/wiki/Methods_of_computing_square_roots

²https://en.wikipedia.org/wiki/Newton's_method

³See Moodle for the original image files.

⁴https://en.wikipedia.org/wiki/List_of_colors:_A%E2%80%93F



Figure 2: Image corrupted with salt and pepper noise



Figure 3: A dark image