

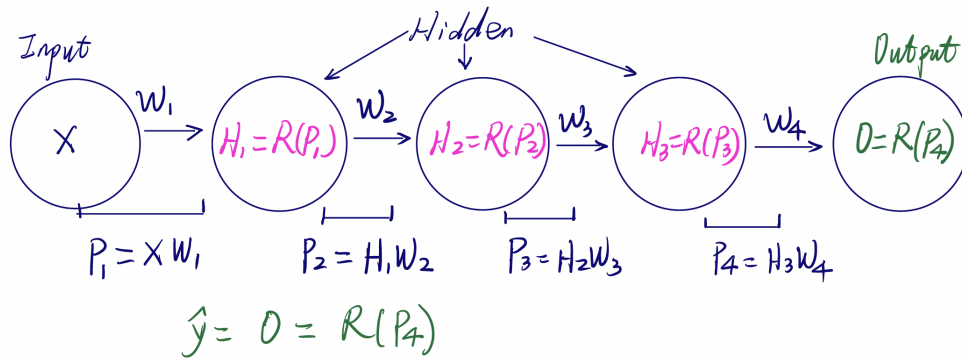
Student Name (print): Farooq Mahmud Group #         

Question:	1	2	3	Total
Points:	10	10	20	40
Score:				

**Instructions:** This homework assignment is divided into three sections:

- The first section requires you to calculate derivatives either by typing or handwriting
- The second section, labeled as problem 2, combines traditional problem-solving with programming. You will begin by manually working out the problem, then you'll develop your own Python code to further solve it. Please submit an *ipynb* file that successfully runs and solves parts c through f, including the generation of relevant plots. This submission should also include a master script that triggers all results and additional functions that support the script.
- The third section repeats the format of last week's coding assignment.

1. (10 points) Let the cost function  $C = \frac{1}{2}(\hat{y} - y)^2$  for the following neural network model with input  $x$  and output  $\hat{y} = O$  (in green).



- What is the derivative of the cost function with respect to  $W_4$ ?
- What is the derivative of the cost function with respect to  $W_3$ ?
- What is the derivative of the cost function with respect to  $W_1$ ?
- What is the output layer error for this network model?
- What is the derivative of the cost function with respect to the hidden layer input  $P_2$ ?

2. (10 points) **Newton's Method** Use Newton's method to approximate  $\sqrt[4]{30}$  and stop the iteration when it is accurate up to 7 decimals.

(a) Form this question into a mathematical problem

$$x^4 - 30 = 0$$

(b) Use Newton's Method to find the (iterative) updating formula for  $x_n$  based on  $x_{n-1}$

$$x_n = x_{n-1} - \left( \frac{x_{n-1}^4 - 30}{4x_{n-1}^3} \right)$$

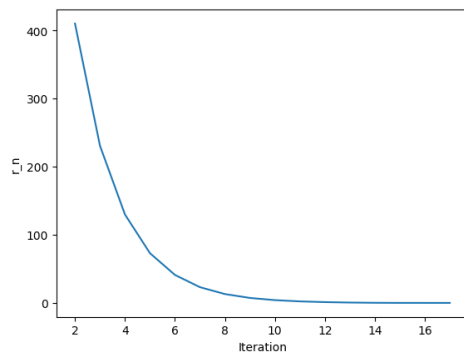
(c) Write a Python function that finds the solution to this problem with a tolerance  $\tau = 10^{-8}$ , where  $\tau = |x_n - x_{n-1}|$ . Instructions:

- Write your code from scratch without using any packages
- Your code should be flexible so that you can change the initial conditions and tolerance

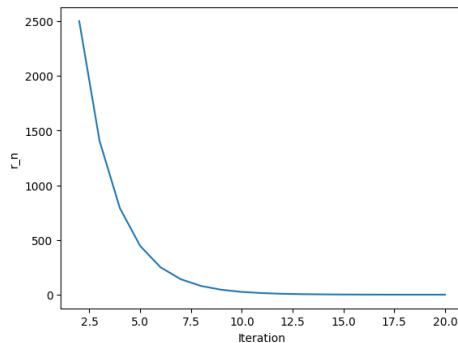
(d) Set your initial condition  $x_0 = 81$ . How many iterations are needed? Write down all the intermediate results (i.e., output  $x_1, x_2, \dots, x_n$ ).

17 iterations are needed

(e) Let  $r_n = (x_n - x_{n-1})^2$ , plot  $r_n$  in Python and save it in eps (Encapsulated PostScript) format (attach the plot with this homework).



(f) Change the initial condition to  $x_0 = 200$ ,  $\tau = 10^{-9}$  and repeat steps (d)-(e). Also, attach the plot with this assignment.



20 iterations needed

(g) Upload your code for this problem on Canvas under this assignment. I will subsequently review and run your code in order to grade your assignment.

3. (20 points) Complete the coding tasks in the file titled *Homework2.ipynb*

Instructions:

- The code with other example codes are available in [Google Drive](https://drive.google.com/drive/folders/1Gc6XcHc7Qr3EGQ_dzpkEdeNdwHdSkbr0?usp=sharing):  
[https://drive.google.com/drive/folders/1Gc6XcHc7Qr3EGQ\\_dzpkEdeNdwHdSkbr0?usp=sharing](https://drive.google.com/drive/folders/1Gc6XcHc7Qr3EGQ_dzpkEdeNdwHdSkbr0?usp=sharing)
- Once you've finished, save your work and rename the file by appending your initials. For instance, if your name is Shusen Pu, you should rename the file as "Homework2-SP.ipynb".
- Make sure all your inputs in the code are saved. Then close and reopen the renamed file (in my case, "Homework2-SP.ipynb") to confirm that all your answers have been saved properly.
- Upload your code on Canvas under this assignment.

I will subsequently review and run your code in order to grade your assignment.