Homework 4

Essay and Programming, Due 21:00, Thursday, November 24, 2022

Late submission within 24 hours: score*0.9;

Late submission before post of solution: score*0.8 (the solution will usually be posted within a week); no late submission after the post of solution)

Total 120%

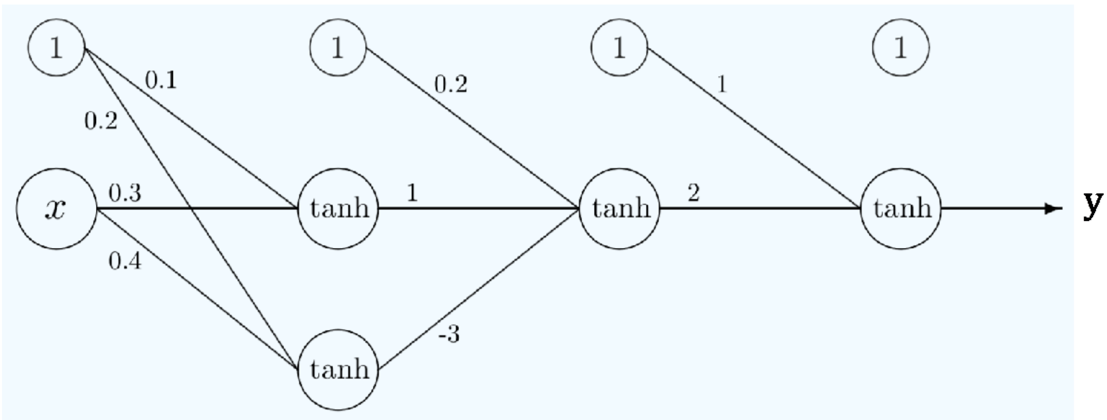
If you have any questions about this homework, contact TA 陳冠亦 (r11521609), and 李國碩 (d10521013).

1. **(60%)** Consider the perceptron model covered in the class and implement the perceptron algorithm from **scratch**. (i.e. you are not allowed to use any other module) Please train your algorithm with the following hyperparameters (or configurations)

```
learning_rate = 0.1, number of epoch = 10, initial_weight = 0.5
```

In the variable *dataset*, the first three numbers of each row are features, and the last number is the class label. Print the weights for each epoch. The output format should be displayed as shown in the **HW4_Prob1.ipynb**. Please submit your Jupyter Notebook.

2. **(40%)** Name your file HW4_Prob2.pdf. Consider the simple network example with a single input $x = 2$ and a single output $y = 1$ shown below, as we have discussed in the lecture.

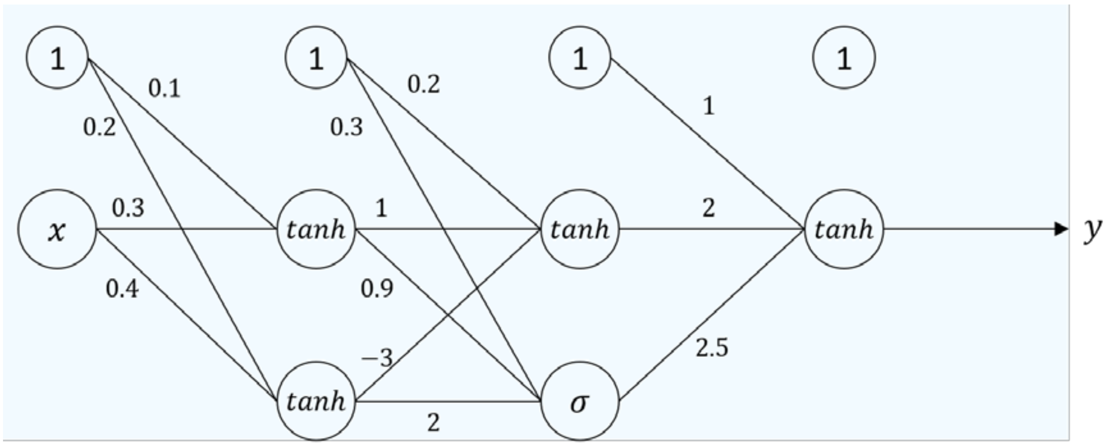


(a) (10%) Using the **half** of the sum square as our error function, derive and compute $\boldsymbol{\delta}^{(3)}$, $\boldsymbol{\delta}^{(2)}$, $\boldsymbol{\delta}^{(1)}$.

(b) (10%) Compute $\frac{\partial e}{\partial \mathbf{W}^{(1)}}$, $\frac{\partial e}{\partial \mathbf{W}^{(2)}}$, $\frac{\partial e}{\partial \mathbf{W}^{(3)}}$.

(c) (20%) Update the weight matrices using this single datapoint with a learning rate $\eta = 0.5$, repeat the forward propagation and compute $\mathbf{s}^{(1)}$, $\mathbf{x}^{(1)}$, $\mathbf{s}^{(2)}$, $\mathbf{x}^{(2)}$, and $\mathbf{x}^{(3)}$.

3. **(30%)** Name your file HW4_Prob3.pdf . Consider the simple network example with a single input $x = 2$ and a single output $y = 1$ shown below.



$$\sigma = sigmoid(x) = \frac{1}{1 + e^{-x}}$$

(a) (10%) Derive and compute $\mathbf{s}^{(1)}$, $\mathbf{x}^{(1)}$, $\mathbf{s}^{(2)}$, $\mathbf{x}^{(2)}$, and $\mathbf{x}^{(3)}$.

(b) (10%) Using the sum square as our error function, derive and compute $\boldsymbol{\delta}^{(3)}$, $\boldsymbol{\delta}^{(2)}$, $\boldsymbol{\delta}^{(1)}$.

(c) (10%) Compute $\frac{\partial e}{\partial \mathbf{W}^{(1)}}$, $\frac{\partial e}{\partial \mathbf{W}^{(2)}}$, $\frac{\partial e}{\partial \mathbf{W}^{(3)}}$.

- **Submission Format:** Please compress `HW4_Prob1.ipynb`, `HW4_Prob2.pdf` and `HW4_Prob3.pdf` into `yourStudentId_hw4.zip`, then upload it to NTU COOL.