Tutorial 3

Backpropagation

BT3017

Due date: 12th February 2024 (Monday) 2359 hrs

Semester 2, AY23/24, School of Computing, National University of Singapore

IMPORTANT:

For this tutorial, you are supposed to submit your project file to CANVAS.

Instruction for submission:

- *Create a folder using the following naming convention:*

  StudentNumber_yourName_Tut3

- *Put your .ipynb file in this folder.*

- *Zip your folder. Name your zip file using the following convention:*

  StudentNumber_yourName_Tut3.zip

  For example, if your student number is A1234567B, and your name is Chow Yuen Fatt, for this tutorial, your file name should be A1234567B_ChowYuenFatt_Tut3.zip

- *Submit the zip file in the "Tutorial-3 Submit Here" folder in CANVAS.*

Note: The code and the dataset for this tutorial were downloaded from the following website (renamed to main.py and wheat-seeds.csv):

https://machinelearningmastery.com/implement-backpropagation-algorithm-scratch-python/

Study the code and the dataset wheat-seeds.csv, then answer the following questions.

Question 1

Read the wheat-seeds.csv file into a dataframe called df_weed.

Display the first 5 rows of data records using the pandas function *head()*. Note that the file does not contain any column names.

Question 2

Add the following column names to the 8 columns of the dataframe df_weed:

'feat1' , 'feat2', 'feat3', 'feat4', 'feat5', 'feat6', 'feat7', 'class'

Display the first 5 rows of data records using the pandas function *head()*.

Question 3

Use Pandas to find out the minimum and maximum values of each column.

Question 4

There was a scaling done on the data before the machine learning process.

a. Write down the formulae used for the scaling.
b. State what would be the max and min values after the scaling.

Question 5

Study the code main.py that was downloaded from the website.

Comment out the statement.
normalize_dataset(dataset, minmax)

Run the code to train the neural network using the dataset wheat-seeds.csv.

Print the scores and mean accuracy as given in the code.

Question 6

Repeat Question 3 but include the statement
normalize_dataset(dataset, minmax)

Compare the scores and mean accuracy obtained with the results obtained in Question 3.

Question 7

Referring to the function *cross_validation_split* :

c. What does the function do?
d. Why is it important to do that? (a 1-sentence answer will do).

Question 8

What does the function *accuracy_metric* do?

Question 9

Which function in the code performs the non-linear perceptron activation?

Give a scientific name to this function.

Question 10

In the function "transfer_derivative", explain why the return value is

output * (1-output)

Question 11

In the function "*backward_propagate_error*", the "*error*" represents (fill in the denominator):

$$error = \frac{\partial E}{}$$

Question 12

In the function "*backward_propagate_error*", "*neuron['delta']*" represents (fill in the denominator):

$$error = \frac{\partial E}{\quad}$$

Question 13

Modify the code to run for 600 epochs instead of 500 epochs in the system (i.e. change the value of n_epoch).

Print the total training error (a scalar) for epochs at 100, 200, 300, 400, 500, 600.

Question 14

Modify the code so that the neural network has two hidden layers. The added hidden layer will be in-between the existing hidden layer and the output layer. Also, the added hidden layer has 4 neurons.