ABIN Assignment 5 (Deep learning)

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Guidelines

1. Deadline: 17th November 2023, 11:59 pm (Midnight).
2. Late submission: 18th November 2023, 11:59 pm (Midnight) (50% of the obtained marks will be deducted).
3. Further late submissions after the 18th November will be awarded zero.
4. All coding assignments must be submitted as .ipynb files with proper comments.
5. Standard IIIT-D plagiarism policy applies.
6. The assignments have to be submitted in the following manner:
   (a) Create a single Jupyter notebook with proper demarcation of questions and responses (text, code, command, explanation, output, graphs). The accepted language is Python.
   (b) A PDF file comprising the entire Jupyter Notebook and a separate Jupyter Notebook file needs to be uploaded (zip format) at the assignment link on Google Classroom before the deadline.
   (c) One group should submit only from the registered submission ID during group formation. Rest of the members must turn in the assignments with private comments mentioning the name, roll, and submission id. Any violation of above will disqualify your submission from evaluation.
   (d) The name of the PDF and jupyter notebook file should be a combination of the group number and assignment number. For example, `group1_1.pdf`, where 'group1' is the group number and '1' is the assignment number.
7. No shift of the deadline is allowed.

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Question 1 (5 Points)

Create a neural network with one hidden layer containing 4 nodes, 2 input nodes, and 1 output node. Apply a sigmoid activation function after the linear block for each case.

1. Initialize the network's weights randomly. [1]
2. Perform backpropagation for 10 epochs and display the updated weights after each iteration. [2]
3. Plot the loss curve and metric curve and analyze the relationship between loss and epoch in backpropagation. [1]
4. Provide a reasoned explanation for the observed relationship. (1)

Question 2 (5 Points)

In our previous discussion about artificial neural networks applied to gene expression data in class, we identified an issue with data imbalance.

1. Implement two potential strategies to address this imbalance, being careful to select appropriate metrics for handling imbalanced data. [1+1]
2. Plot the loss versus epoch and metric versus epoch curves. [0.5+0.5]
3. Justify why both strategies are effective for handling imbalanced data. [1+1]

Question 3 (5 Points)

In our previous discussion about artificial neural networks and gene expression data, we recognized that the dataset had a limited number of samples. A standard train-test split may lead to high variance due to the random state.

1. Propose and implement two strategies that provide more reliable model estimations when dealing with a small sample size. [1+1]
2. Plot the loss versus epoch and metric versus epoch curves for all possible cases. [0.5+0.5]
3. Provide a rationale for why both strategies are expected to be effective. [1+1]