School of Electrical and Computer Engineering- University of Tehran
Artificial Intelligence Course- 2024
Assignment 1-Due Date: April 10, 2024, before 4 PM

1. Explain the mathematical intuition behind the following optimizers used to optimize deep neural networks.[length of your recording ≤ 10 minutes].

A. Stochastic Gradient Descent+ Momentum (SGD+ Momentum)
B. Adagrad
C. RMSprop

I already discussed (SGD) and SGD+ Momentum in lecture 2.

SGD

$$\theta = \theta - \alpha \cdot \nabla_\theta J(\theta)$$

SGD+ Momentum

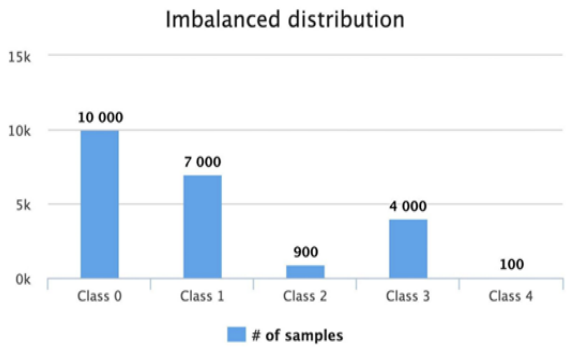
$$v_t = \gamma v_{t-1} + \eta \nabla_\theta J(\theta)$$

$$\boxed{\theta = \theta - v_t}$$

2. Explore the literature and find out which of the above optimizers are preferred in real-world applications. In doing so, you should compare the performance of the above optimizers and address the advantages and disadvantages of each when training neural networks. [length of your recording ≤ 10 minutes].

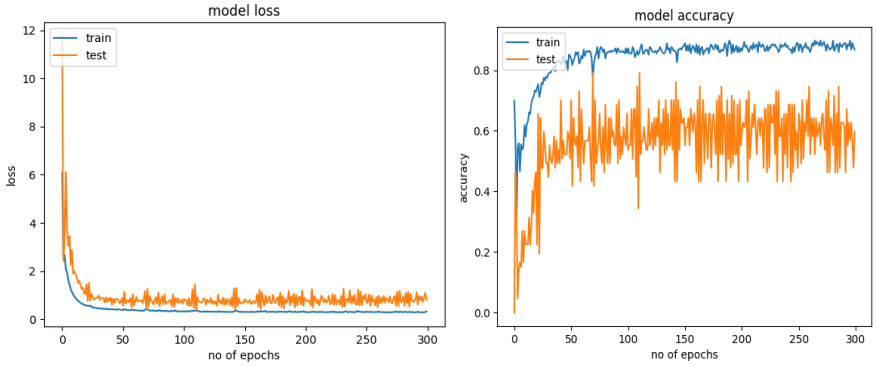
3. In machine learning/deep learning models, we often encounter imbalanced datasets in which one class has fewer instances than the other. An imbalance in the number of samples/examples leads to suboptimal performance in our machine learning/deep learning models. To solve this problem, various techniques have been proposed, including the Synthetic Minority Oversampling Technique (SMOTE). SMOTE is a sampling method that oversamples the minority class. You should explain the mathematics of the SMOTE algorithm and show how it can improve the performance of our deep neural network models. You should provide an example using Python and TensorFlow. [length of your recording ≤ 10 minutes].

Example of an imbalanced dataset



4. I have provided you with a dataset in our AI course Google Link and named it **[Assignment 1-Dataset].** The feature names are F1, F2, F3, etc. The last column is the target. **[length of your recording $\leq$ 15 minutes].**

A. You should build a classification model employing a Deep Neural Network using this dataset. You should elucidate all the codes in your notebook.
B. You should use SMOTE with Adagrad and RMSprop and compare your results. Make sure you correctly apply the SMOTE to your data.
C. You should plot the loss and accuracy for the training and validation. See the plots below.



Important Note

1. For this assignment, you should record a video. You should show your face. Your voice must be clear. It is your responsibility to make sure your video is working. You should put your video and notebook in Google Drive. Your folder should have your[student ID number, first name, and last name]. Only one video should be submitted for all parts of this assignment.
2. Your notebook should be well structured, and before each code block, you should explain the codes of the next block. You should follow the format of the notebooks I presented in the lectures.
3. You should make your Google link open access and submit your video to the auxiliary TA of our course, Mr Behzad Mohasel Afshari, via e-mail on April 10, 2024, before 4 PM. His e-mail for this course is ai.2024.cs@gmail.com.
4. You should use Google Colab. Insert all the slides into your Google Colab environment, then record all parts of this assignment.
5. You should submit the following two items
A. Your Google Colab notebook.
B. Your video file. The extension of your video file should be .mp4. Other formats will not be accepted.
6. Your video file and notebook should be saved as [student ID number, first name, and last name]. Your total video file should not be more than 45 minutes. Your recording must be in English.
7. You should ensure that your codes and mathematical algorithms are flawless.
8. In our AI course Google Link, I have provided an example of a binary classification problem using 1 Dense layer in the folder [Example- Binary_Classification_H_Disease-2024].
9. If you encounter any difficulties with AI algorithms, Python, and TensorFlow, first contact the main TA of our course, Mr Amir Abbas Yahyaeian, and if the issue is not resolved, please get in touch with me. If further elucidation is warranted, please don't hesitate to contact me.

I wish you a rejuvenating break.