CPC251: Machine Learning and Computational Intelligence
Academic Session: Semester 2, 2023/2024
School of Computer Sciences, USM, Penang

Assignment 1

Overview

This is a group assignment.

This assignment provides you the opportunity to learn low-level TensorFlow programming. In the assignment, you are given a dataset which can be downloaded from eLearn@USM. You need to implement the gradient descent algorithm to estimate (train) the weights a neural network model.

Requirements

Define the following functions.

```
def loss_fn():
    """
    This function calculates the loss function
    """


def sigmoid():
    """
    This function calculates the sigmoid function.
    """


def relu():
    """
    This function calculates the ReLU function.
    """


def forward():
    """
    This function calculates the forward pass (predicts the label).
    """


def train():
    """
    This function performs the forward pass, computes the gradient and update the
weights and biases.
    """


def fit():
    """
    This function implements the training loop.
    """
```

Use low-level TensorFlow programming (TensorFlow without Keras).

Create a neural network with a single hidden layer with ReLU activation. You may define your own number of units in the layer.

Split the given dataset into three training, validation and test with a ratio of 7:1:2.

Use the training set to estimate the weights, the validation set to validate the model and the test set to evaluate the linear regression model with the estimated weights.

Display the training loss and validation loss values for each epoch of the training loop.

Display the training loss and validation loss against epoch graph (after model training).

Evaluate the neural network model with the estimated weights on the test set and display the confusion matrix and the classification report.

Document the codes using comments.

Note: Focus on the algorithm implementation (model is learning from the data), not the accuracy of the model.

Additional tasks (optional):

Train the model using mini-batch gradient descent.

Implement early stopping regularization.

Submission requirements

- Due date: **13 May 2024 (Monday)**, 11:59 p.m. (Week 8).
- Use the given jupyter notebook template. Do not change the function name.
- The jupyter notebook must be executed to show the outputs.
- Submission must be made in ipynb format (submitted online).
- The filename must follow these naming conventions.
    - <CPC251_Assignment1_GroupNo.ipynb>
- Plagiarism (using other people's ideas and text without proper acknowledgment and using them as your own) is a serious academic offence. The consequences for plagiarism are severe.

Rubric

Component	10-9 (Excellent)	8-6 (Good)	5-2 (Average)	1-0 (Poor)	Weightage
Requirements and Delivery	The functions are implemented. All the outputs (training loss, validation loss, graph and model evaluation) are displayed.	The functions are implemented. All the outputs (training loss, validation loss, graph and model evaluation) are displayed with minor mistakes.	Some of the functions are not implemented. All the outputs (training loss, validation loss, graph and model evaluation) are displayed with major mistakes.	The functions are not implemented. The outputs are not displayed	3
Runtime and Algorithm	Executes without errors. The algorithm is correct.	Executes without errors. The algorithm is correct with minor mistakes.	Executes without errors. The algorithm is partially correct.	Does not execute due to error. The algorithm is incorrect.	3
Efficiency	Solution is efficient, easy to understand, and maintain.	The code is fairly efficient without sacrificing readability and understanding.	A logical solution that is easy to follow but it is not the most efficient.	A difficult to understand and inefficient solution. Code is huge and appears to be patched together.	3
Documentation	The source codes are well documented and commented.	The source codes are partially documented and commented.	The source codes are minimally documented and commented	The source codes are not documented and commented	1