

## ECE 805 – Machine Learning

### Homework #03

Spring 2023

(due on Thursday, 16 February 2023, 00:00, submitted via Teams)

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#### General instructions

This assignment consists of two questions. You are requested to submit both your code and a report; the report should contain the requested visualisation plots and your answers to possible questions.

Please submit one compressed file (zip), named ECE805\_HW3\_Yourname.

#### Exercise 1 (50%):

*You can use the online [google colab](https://colab.research.google.com/) platform. Even with a cpu backend the execution time is reasonable to complete the exercise. The versions of the Python packages that were used were as follows: Tensorflow: 2.9.2, Pandas: 1.3.5, Numpy: 1.21.6*

You are given the code in `NN_train.py`. Inspect the code and comments to familiarize yourself with what it does. In this exercise you will investigate how different hyperparameters, such as number of neurons and learning rate can influence the performance of a neural network.

The code trains a dense neural network to classify images into 10 classes using the FASHION\_MNIST dataset. By default, the code outputs the **best validation accuracy** over 30 epochs and plots the **training and validation accuracy and loss values**. These are the metrics that you will have to inspect.

(a) Configure the network so that each dense layer has 10 neurons. For the learning rates [1e-1, 1e-2, 1e-3, 1e-4, 1e-5] run the training script and monitor how the validation accuracy changes. Comment on how the loss and accuracy curves change with the different values and what is the best validation accuracy.

(b) Now fix the learning rate to 5e-3. Change the number of neurons in each layer between [2,4,10], keep the same number of neurons for each dense layer. Run the training script and monitor how the validation accuracy changes. Comment on how the loss and accuracy curves change with the different values and what is the best validation accuracy.

(c) For a fixed number of 4 neurons and learning rate 5e-3, add a dropout layer between the two intermediate dense layers. Use dropout rates of 0.2 and 0.5. For the two dropout rates run the training script and monitor how the validation accuracy changes. Comment on how the loss and accuracy curves change with the different values and what is the best validation accuracy. What is the impact of dropout on the overall training.

Hand in all code and a report explaining the impact of the different hyperparameters with your observations. You should evaluate a total of 10 configurations.

**Exercise 2 (50%):**

- (a) Define **one-pass** learning. State its advantages and disadvantages, and in what cases it is most useful.
- (b) Define **incremental** learning, and state its advantages and disadvantages. Also, describe an alternative approach to incremental learning.
- (c) A **real** concept drift is a more important problem than **virtual** concept drift. State if this is True or False, and justify your answer.
- (d) In online active learning, describe two methods that can improve an uncertainty-based sampling strategy?