**German International University of Applied Sciences**
**Informatics and Computer Science**
Dr. Caroline Sabty
Eng. Nadeen Amr

**Machine Learning**, Winter 2022
**Mini Project 3**
**Due date is January 6, 2023 at 11:59 PM**
**To be solved *individually***

You are required to design a Fisher's Linear Discriminant classification algorithm that can recognize scanned images of the 10 digits (0 to 9) that you have used in the previous Mini Project. The images in the "Train" folder should be used to train a classifier for each digit using the method used in Mini Project 2 (*For Fischer's, you will assign an image to a digit based on the **minimum** product (not maximum as in least squares classifier)*). The folder contains a file named "Training Labels.txt" which includes the labels of the 2400 images in order. After the classifiers are trained, test each classifier using the images given in the "Test" folder. Use the following equation for Fisher's Linear Discriminant $w = S_w^{-1}(m_2 - m_1)$. **You will examine Fisher's Linear Discriminant twice. Once without including a bias term in each discriminant function and another using a bias term for each discriminant function.** For each time, you will produce a <u>confusion matrix</u> as well as the <u>accuracy</u> of your classifier.

Deliverables that should be in your submitted Notebook:

a) Your code.

b) A confusion matrix without using the bias term. Convert the confusion matrix to an image and save it as "ConfusionNoBias.jpg".

c) A confusion matrix while using the bias term. Convert the confusion matrix to an image and save it as "ConfusionWithBias.jpg".

d) Comment on whether the use of a bias term has affected the performance of the classifier or not.

**Important Notes**:

- If the inverse of $S_w^{-1}$ results in a singular matrix, use the pseudoinverse function.

- Your target values should be 0 and 1.

- **Do not use Python built-in functions for mean, covariance or the Fisher's linear discriminant. You have to implement your own version of all needed functions (reading the images and the confusion matrix are the only exceptions).**

- Submit your notebook using the email <u>machine604learning@gmail.com</u>

PLAGIARISM IS NOT TOLERATED AND COPIED WORK WILL BE AWARDED 0 POINTS FOR BOTH PERSONS INVOLVED (yes, even if you got the code somewhere from the internet and you understand it too! That is also NOT ALLOWED)!