ITEC 563 - Neural Networks and Deep Learning
Project #1 - Wine Quality Classification Using Deep Learning

Project Title: **Wine Quality Classification Using Deep Learning**

Objective:
The goal of this project is to design, implement, and evaluate a deep learning architecture for classifying wine quality based on physicochemical properties of red and white wine samples. The project will provide hands-on experience in designing and applying deep neural network models, with a focus on solving a real-world multi-class classification problem.

Dataset:
The dataset for this project is available online at the UCI Machine Learning Repository: Wine Quality Dataset. It contains physicochemical properties (input features) of red and white wines from the Vinho Verde region of Portugal, as well as quality ratings (output labels). The classification task is to predict the wine quality based on these features.

Red Wine Dataset: Contains data for red wine samples, including features like acidity, sugar levels, and alcohol content.

White Wine Dataset: Contains data for white wine samples with similar features.

Dataset link: https://archive.ics.uci.edu/dataset/186/wine+quality

Requirements:

- You should develop and train separate models for the red and white wine datasets.
- You may use any programming language or toolbox of your choice, with Python, MATLAB, or Octave being strongly recommended.
- Techniques like data normalization, feature selection, and dropout can be applied to improve model performance. You are encouraged to experiment with different architectures, optimizers (e.g., SGD, Adam), and learning rates to achieve better results.
- Submit the project as a document with the code attached or linked. Ensure that the report includes well-commented code snippets or relevant explanations for the key parts of the implementation.
- Your submission should include a project document structured as follows:
  - **Introduction**: Briefly introduce the wine classification problem and its significance in wine production. Describe the red and white wine datasets, including a summary of their structure and the quality ratings (output variable).
  - **Model Design**: Provide an overview of the neural network architecture you designed. Justify your choice of architecture, layers, activation functions, and any other key components. Discuss any pre-processing steps applied to the data, such as normalization or feature selection.
  - **Implementation**: Explain the programming environment (e.g., language, libraries, and tools) you used for implementation. Provide details on how you divided the dataset into training, validation, and test sets. If using any pre-written code, ensure you properly cite its source and explain the algorithm.
  - **Training Process**: Describe the training process, including the optimizer, learning rate, batch size, and the number of epochs. Mention any challenges you faced during training (e.g., overfitting) and how you addressed them.
  - **Evaluation**: Evaluate the performance of your models using appropriate metrics such as accuracy, precision, recall, and F1-score. Compare the performance of the models for red and white wine. Include visualizations of the loss and accuracy over epochs and confusion matrix results for both models.
  - **Conclusion**: Summarize your findings and the effectiveness of your models for red and white wine quality prediction. Suggest potential improvements or alternative approaches for better performance.

Evaluation Criteria:

- **Clarity and Organization**: Is the report clear and well-structured? Are the explanations concise?
- **Model Design**: Is the architecture well-justified, and are the design choices explained?
- **Implementation**: Is the code functional and well-documented? Does the student understand the underlying algorithms?
- **Performance Evaluation**: How well do the models perform on the red and white wine datasets? Are the results well-analysed?
- **Originality**: Is the approach innovative or insightful? Have interesting techniques been used to improve performance?