Understanding and Implementing 1D and 2D Convolutional Neural Networks (CNNs)

🎯 Objectives

By the end of this assignment, students should be able to:

- Understand the differences between 1D and 2D Convolutional Neural Networks.
- Identify use-cases where each type is suitable.
- Implement 1D CNN for text classification.
- Implement 2D CNN for image classification.
- Evaluate model performance using accuracy, confusion matrix, etc.

🧠 Part A: Theory Section

🧩 What is a CNN?

A Convolutional Neural Network (CNN) is a class of deep neural networks commonly used to analyze visual imagery. CNNs are particularly powerful for extracting local patterns using convolutional layers.

🔷 1D CNN

- Operates on **1-dimensional** sequential data (e.g., text, time series).
- Each filter slides over the **sequence** in one direction (time/word order).
- Commonly used for:
    - Text Classification
    - ECG Signal Processing
    - Audio Classification

🔷 2D CNN

- Operates on **2D structured data** (images).
- Filters slide over both **height and width** of the input.
- Commonly used for:
    - Image Classification
    - Object Detection

- Medical Image Analysis

💻 **Part B: Practical Tasks**

📌 **Task 1: Implement 1D CNN on IMDB Text Classification**

🔧 **Requirements:**

- Use Keras' IMDB dataset.
- Preprocess using embedding and padding.
- Build a 1D CNN model with:
  - Embedding → Conv1D → GlobalMaxPooling1D → Dense
- Evaluate the accuracy.

📌 **Task 2: Implement 2D CNN on MNIST Image Classification**

🔧 **Requirements:**

- Use Keras' MNIST handwritten digit dataset.
- Preprocess images (normalize and reshape).
- Build a 2D CNN model:
  - Conv2D → MaxPooling2D → Flatten → Dense
- Evaluate model performance.

📋 **Part C: Answer the Following Questions**

1. What are the key differences between 1D and 2D CNNs?
2. Why is padding used in convolutional layers?
3. What does a filter/kernel do in a CNN?
4. How does a max pooling layer affect the feature map?
5. Why are CNNs preferred over Feedforward Neural Networks for spatial/temporal data?

📎 **Submission Requirements**

- Submit a .ipynb or .py file for both 1D and 2D CNN implementations.
- Include answers to theoretical questions in a .pdf or markdown cell.

- Include graphs (loss/accuracy) and confusion matrix (optional).
- Deadline: 13/05/2025