

# SKILL SHIKSHYA & VRIT TECHNOLOGIES

## Data Science and Machine Learning (DSML) Course

### PROJECT PROPOSAL

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**Project Title: Intelligent Handwritten Digit Recognition System Using Convolutional Neural Networks**

#### 1. Background and Problem Statement

Handwritten digit recognition is a classical computer vision problem with real-world applications in banking, postal services, form digitization, and document processing. Traditional machine learning methods require manual feature extraction and struggle with complex visual patterns. This project aims to design and implement an intelligent digit recognition system using **Convolutional Neural Networks (CNNs)** that can automatically learn spatial features from images and achieve high classification accuracy.

#### 2. Objectives

- To build an end-to-end CNN-based handwritten digit classification system
- To preprocess and normalize image data effectively
- To visualize learned CNN feature maps for model interpretability
- To evaluate model performance using accuracy, confusion matrix, and error analysis
- To deploy the trained model using a simple web interface

#### 3. Dataset

- **MNIST Handwritten Digits Dataset**
- 60,000 training images and 10,000 test images
- Grayscale images of size 28×28 representing digits (0–9)

#### 4. Methodology

- a) **Data Preprocessing**
  - Normalization and reshaping of image data
  - One-hot encoding of target labels
- b) **Model Development**
  - Design of CNN architecture using TensorFlow/Keras
  - Convolution, ReLU activation, pooling, flattening, and dense layers
- c) **Training and Optimization**
  - Adam optimizer and categorical cross-entropy loss
  - Hyperparameter tuning (epochs, batch size)

- d) **Evaluation**
  - o Accuracy and loss curves
  - o Confusion matrix and misclassification analysis
- e) **Visualization**
  - o Feature map visualization of convolutional layers
  - o Understanding learned filters
- f) **Deployment**
  - o Web interface using **Streamlit** for real-time digit prediction

## 5. Tools and Technologies

- Python
- NumPy, Pandas, Matplotlib, Seaborn
- Scikit-learn
- TensorFlow / Keras
- Streamlit

## 6. Expected Outcomes

- A trained CNN model achieving high classification accuracy (>98%)
- Clear understanding of CNN internals through feature visualization
- A working web application for digit recognition
- Practical exposure to end-to-end ML project lifecycle

## 7. Conclusion

This project demonstrates the application of deep learning techniques in computer vision and reflects the practical competencies gained throughout the Data Science and Machine Learning diploma program. The project integrates theoretical knowledge with hands-on implementation, evaluation, and deployment.