Phase-2 Submission Template

Student Name: *Karthika.G*

Register Number: *613023104048*

Institution: *Vivekanandha College of Technology for Women*

Department: *BE - Computer Science and Engineering*

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Github Repository Link: https://github.com/karthi200622/Karthika.G.git

1. Problem Statement

- *Recognizing handwritten digits is a critical task in AI systems with real-world applications such as postal code reading, bank check processing, and digital form entry.*

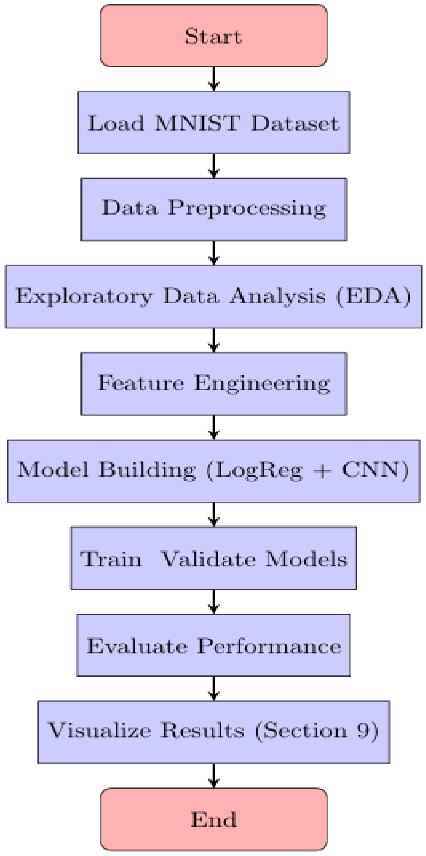
- *Traditional methods fail due to handwriting variability..*

- *This project tackles the classification problem using deep learning, aiming for accurate, scalable, and robust recognition across various handwriting styles.*

2. Project Objectives

- *Build an AI model that can accurately classify digits (0–9) from handwritten images.*
- *Achieve high accuracy using deep learning models such as neural networks (e.g., CNNs).*
- *Develop a user-ready model applicable to real-world tasks like postal and banking automation.*

3. Flowchart of the Project Workflow



4. Data Description

- *Dataset&source: MNIST Handwritten Digits &kaggle*
- *Type of data: Image, structured (28x28 grayscale)*
- *Records: 70,000 total (60K train, 10K test)*
- *Static or dynamic: Static*
- *Target variable : Digit class (0 to 9)*

5. Data Preprocessing

- *Normalized pixel values to [0, 1] range.*
- *Converted labels to one-hot encoding (for classification).*
- *Checked for nulls (none found in MNIST).*
- *No duplicates due to standardized dataset.*
- *Image reshaped for CNN input where needed (e.g., 28x28x1).*

6. Exploratory Data Analysis (EDA)

- *Univariate Analysis:*
  - *Countplot of digit distribution (0-9) shows balanced data. Visual samples of each digit using matplotlib.*
- *Bivariate/Multivariate Analysis:*
  - *Mean and variance of pixel intensities analyzed.*
  - *Heatmaps used to show pixel intensity patterns across digits.*
- *Insights Summary:*

Some digits have higher visual similarity (e.g., 3 and 5), which may cause misclassification.

○ *Pixel intensity helps the model understand the shape of each digit.Edges and corners are important to tell digits apart, like 1 vs7.Middle part of the image is most useful since digits are usually centered.Unique patterns, like curves or straight lines, help the model learn differences (e.g., between 3 and 8).*

7. Feature Engineering

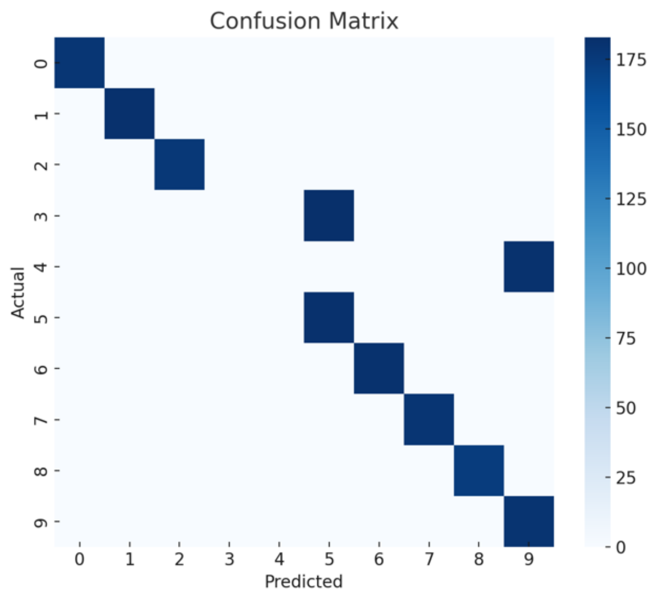
- *Used pixel values directly as features.*
- *Applied reshaping for CNN models.*
- *Tried PCA for dimensionality reduction as optional enhancement.*

8. Model Building

- *Models used:*
  - *Baseline: Logistic Regression*
  - *Advanced: Convolutional Neural Network (CNN)*
- *Model Justification:*
  - *Logistic regression to establish a simple baseline.*
  - *CNNs for spatial feature extraction—ideal for image tasks.*
- *Evaluation Metrics: Accuracy, Precision, Recall, F1-score*
- *Best Accuracy Achieved: ~98% using CNN*

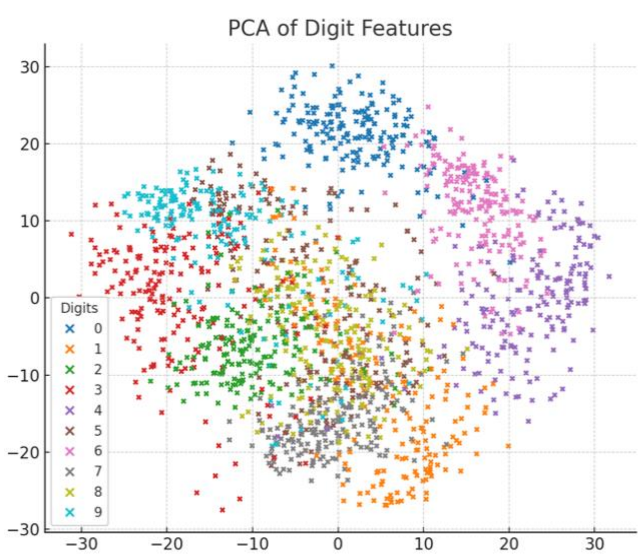
9. Visualization of Results & Model Insights

- *Confusion Matrix: Showed misclassifications, mostly in 4/9, 3/5.*



- *Accuracy & Loss Curves: Used to monitor overfitting.*

- *Feature Importance (for non-CNN): Used PCA to visualize key components.*



10. Tools and Technologies Used

- *Programming Language: Python*
- *IDE : Google Colab*
- *Libraries: NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn, TensorFlow/Keras*
- *Visualization Tools: Matplotlib, Seaborn*

11. Team Members and Contributions

- *Dharani.R*

    ○ *Data cleaning (Load and clean data Normalize and split into train/test sets)*

- *Karthika.G*

    ○ *EDA (Create and train the machine learning model (e.g., CNN) Tune hyperparameters)*

- *Harshitha shree.A.S*

    ○ *Feature engineer(Check model accuracyPlot confusion matrix, accuracy &loss graphs)*

- *Lavanya.R*

    ○ *Model development(Apply PCA & Visualize and analyse feature clusters)*

- *Monisha.P*

    ○ *Documentation and reporting(Write project report Prepare slides and visuals*