**Phase-1 Submission**

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**1.Problem Statement**

*Handwritten digit recognition is a crucial task in machine learning and computer vision. It refers to the automatic identification of digits (0-9) from images of handwritten characters. This problem has real-world applications in many fields, including postal services (address recognition), bank checks (digit recognition for amounts), and form processing systems.*

**2.Objectives of the Project**

*By the end of the project, the following objectives are to be achieved:*

* ***Build a machine learning model*** *capable of accurately recognizing handwritten digits from images.*
* ***Analyze model performance*** *to identify which algorithms and techniques yield the highest accuracy.*
* ***Optimize the model*** *by fine-tuning hyperparameters and experimenting with different feature engineering methods.*
* ***Deploy the model*** *as a working application that can classify new handwritten digits, enabling real-time predictions for practical use.*

**3.Scope of the Project**

*The project will focus on the following features:*

* ***Dataset****: Utilize the MNIST dataset, a collection of 28x28 grayscale images of handwritten digits (0-9).*
* ***Model****: The model will be built using different algorithms, such as k-Nearest Neighbors (k-NN), Logistic Regression, Support Vector Machines (SVM), and Convolutional Neural Networks (CNN).*
* ***Feature Engineering****: Basic image processing techniques, like normalization and resizing, will be employed, along with potentially experimenting with advanced techniques such as PCA (Principal Component Analysis) for dimensionality reduction.*
* ***Deployment****: The model will be deployed as a simple web application for digit classification.*

**4.Data Sources**

*The dataset used for this project will be the* ***MNIST dataset*** *(Modified National Institute of Standards and Technology), which consists of 60,000 training images and 10,000 test images of handwritten digits.*

* ***Source****: The dataset is publicly available on platforms like Kaggle and the official MNIST website.*
* ***Type****: Public dataset.*
* ***Format****: The dataset is static and will be downloaded and used for model training and testing.*
* ***Data Source link****:* *https://www.geeksforgeeks.org/handwritten-digit-recognition-using-neural-network/*

**5.High-Level Methodology**

*The following steps will be followed to execute the project:*

* ***Data Collection****: Download the MNIST dataset from public repositories (e.g., Kaggle or official MNIST site).*
* ***Data Cleaning****: While the MNIST dataset is already preprocessed, we will ensure there are no missing values, duplicates, or inconsistencies. Image resizing and normalization (scaling pixel values to a range of 0-1) may also be performed.*
* ***Exploratory Data Analysis (EDA)****: Visualize a subset of images to identify patterns and characteristics. Use histograms, correlation matrices, and other techniques to understand the distribution of digits and their features.*
* ***Feature Engineering****: The primary features in the dataset are the pixel values of the images. Additional transformations may include dimensionality reduction (e.g., PCA) to speed up training or improve performance.*
* ***Model Building****: Experiment with various machine learning algorithms, including:*
  + *k-Nearest Neighbors (k-NN)*
  + *Logistic Regression*
  + *Support Vector Machines (SVM)*
  + *Convolutional Neural Networks (CNN)*

*The CNN model will likely perform best for this image recognition task due to its ability to detect spatial hierarchies in images.*

* ***Model Evaluation****: Evaluate the models using accuracy, precision, recall, and confusion matrices. Cross-validation will be employed to ensure the robustness of the results.*
* ***Visualization & Interpretation****: Use visualizations to present model performance (e.g., confusion matrix, ROC curves). Summarize the findings and interpret the significance of model performance.*
* ***Deployment****: Build a simple web application to deploy the model using Flask or Streamlit. Users will be able to upload an image and receive a prediction of the handwritten digit.*

**6.Tools and Technologies**

*The following tools and technologies will be used in the project:*

* ***Programming Language****: Python will be used for implementing the machine learning models and data processing tasks.*
* ***Notebook/IDE****: The project will be developed using* ***Google Colab*** *or* ***Jupyter Notebook*** *for code execution and experimentation.*
* ***Libraries****:*
  + ***pandas*** *and* ***numpy*** *for data manipulation and numerical computation.*
  + ***matplotlib*** *and* ***seaborn*** *for data visualization.*
  + ***scikit-learn*** *for machine learning algorithms and metrics.*
  + ***TensorFlow/Keras*** *for building and training Convolutional Neural Networks (CNN).*
  + ***OpenCV*** *for any additional image preprocessing.*
* ***Optional Tools for Deployment****:*
  + ***Flask*** *or* ***Streamlit*** *for creating a simple web application for model deployment.*

**7.Team Members and Roles**

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| **Name -Role** | **Responsibilties** | **Skills** |
| ***1. Jagadesh R - Team Lead*** | * *Oversee project and coordinate team tasks.* * *Ensure deadlines and milestones are met.* * *Serve as the point of contact for external communication.* * *Facilitate meetings and manage the final presentation.* | * *Strong organizational and communication skills.* * *Technical understanding of the project.* * *Ability to track deadlines and allocate tasks efficiently* |
| ***2. Risikesh N - Data Scientist (Model Building)*** | * *Collect and preprocess the dataset (MNIST).* * *Perform EDA and develop machine learning models (k-NN, Logistic Regression, CNN).* * *Tune models, evaluate, and ensure optimal performance.* | * *Expertise in machine learning (scikit-learn, TensorFlow, Keras).* * *Proficient in data preprocessing, feature extraction, and model evaluation.* |
| ***3. Santhosh S - Data Engineer (Preprocessing & Feature Engineering)*** | * *Ensure clean, structured data for model training.* * *Implement data preprocessing and handle dataset management.* * *Perform data cleaning and automation for future updates.* | * *Experience with data manipulation (pandas, numpy).* * *Knowledge of data cleaning and managing large datasets.* |
| ***4. Rajan N - Front-End Developer (Deployment & UI)*** | * *Design and implement the web application UI.* * *Ensure users can upload handwritten images and view predictions.* * *Collaborate with the Back-End Developer for integration.* | * *Proficiency in HTML, CSS, JavaScript, and front-end frameworks.* * *Experience with responsive web design and UX/UI principles.* |
| ***5. Sarath Vel K V - Back-End Developer (Model Integration & Deployment)*** | * *Set up the back-end server for model access and real-time predictions.* * *Integrate the machine learning model with the front-end UI.*   *Manage model deployment, scalability, and security.* | * *Expertise in Python, Flask, FastAPI, or Streamlit.* * *Knowledge of model deployment, cloud services (AWS, GCP), and API integration* |