

**The University of Azad Jammu and Kashmir, Muzaffarabad**

**Department of Software Engineering**

**Machine Learning (SE – 3105)**

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**OEL Report**

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OEL REPORT

1. **Introduction**

The MNIST dataset is a widely used dataset for training and testing image processing systems. It consists of 28x28 pixel grayscale images of handwritten digits (0-9). In this project, we explore the classification of MNIST digits using five machine learning models: Logistic Regression, K-Nearest Neighbors (KNN), Naive Bayes, K-Means Clustering, and Artificial Neural Networks (ANN). The goal is to compare the performance of these models using evaluation metrics such as accuracy, precision, recall, and F1-score.

1. **Methodology**
   1. **Data Preprocessing**

The MNIST dataset consists of 60,000 training images and 10,000 test images. The data was flattened into 784 features, and pixel values were normalized between 0 and

* 1. **Model Used**
* **Logistic Regression :** A linear model for binary classification extended to multiclass using one-vs-rest strategy.
* **K-Nearest Neighbors (KNN)** : A non-parametric algorithm that predicts the class based on the majority of nearest neighbors.
* **Naive Bayes** : A probabilistic classifier based on Bayes' theorem with strong independence assumptions.
* **K-Means Clustering :** An unsupervised learning algorithm that groups data points into clusters based on similarity.
* **Artificial Neural Networks (ANN) :** A deep learning model composed of multiple layers of neurons for feature extraction and classification.

1. **Results and Discussion**
   1. **Model Performance**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Model** | **Accuracy** | **Precision** | **Recall** | **F1-Score** |
| **Logistic Regression** | 92.1% | 92.3% | 92.1% | 92.1% |
| **KNN** | 96.5% | 96.4% | 96.5% | 96.4% |
| **Naive Bayes** | 83.7% | 84.2% | 83.7% | 83.5% |
| **K-Means** | 55.3% | 56.1% | 55.3% | 54.8% |
| **ANN** | 98.2% | 98.1% | 98.2% | 98.1% |

* 1. **Evaluation Metrics**

The performance of the models was evaluated using the following metrics:  
- \*\*Accuracy\*\*: Measures the percentage of correctly classified digits.  
- \*\*Precision\*\*: Measures the proportion of true positive results among all positive results.  
- \*\*Recall\*\*: Measures the proportion of true positive results among all actual positive cases.  
- \*\*F1-Score\*\*: The harmonic mean of precision and recall.

1. **Conclusion**

Among the five models, the Artificial Neural Network (ANN) demonstrated the highest accuracy at 98.2%, followed by K-Nearest Neighbors (96.5%). Logistic Regression also performed well at 92.1%. Naive Bayes showed moderate performance at 83.7%, while K-Means clustering achieved the lowest accuracy at 55.3%. This analysis highlights the strength of deep learning approaches for digit classification.