CSIT 598 Machine Learning

Assignment 1

Due: 23:59 Oct. 7, 2024

Objective

In this assignment, you will implement and evaluate several classification algorithms on the MNIST dataset `https://yann.lecun.com/exdb/mnist/`. The goal is to compare the performance of different machine learning algorithms and analyze their strengths and weaknesses.

Dataset

You will work with the MNIST dataset (handwritten digits), which has been widely used in research for benchmarking. You may use preprocessed versions of the dataset available through libraries such as `TensorFlow` or `scikit-learn` for MNIST.

Tasks

1. Decision Tree Classifier (0.5 points)

- Implement a Decision Tree classifier

- Evaluate its performance using the accuracy metric

2. Naive Bayes Classifier (1 point)

- Implement two Naive Bayes classifiers, i.e., Gaussian and Multinomial

- Compare the performance of the two and report your observations

3. Support Vector Machine (SVM) (1.5 points)

- Implement a Support Vector Machine (SVM) classifier

- Experiment with different kernels, i.e., linear and RBF

- Compare the performance of the two and report your observations

4. k-Nearest Neighbors (k-NN) (1 point)

- Implement the k-Nearest Neighbors (k-NN) algorithm.

- Experiment with different values of k and report your optimal k value

5. Ensemble Methods (2 points)

Implement the following ensemble methods and compare their performances:

- **Bagging:** Apply Bagging using Decision Trees as base estimators

- **Random Forest:** Implement a Random Forest classifier

- **Boosting:** Apply AdaBoost with Decision Trees as base estimators

6. Performance Comparison and Analysis (4 points)

- Summarize your findings. Which model performed the best? What are the trade-offs between the different classifiers?

Submission Guidelines

- Assignment should be submitted via Canvas

- Submit a single .zip file that contains

  - Codes in .ipynb formats, which should be into one folder named *codes*
  - A report (either in Microsoft word or latex) summarizing your findings