Assignment 1

Shreyash Dwivedi (221035)

- Colab notebook link- https://colab.research.google.com/drive/1Tr0fcr8Ck6Wg0pbiseyEGPJ-qpcVgFZf?usp=sharing

Summary of the Notebook:

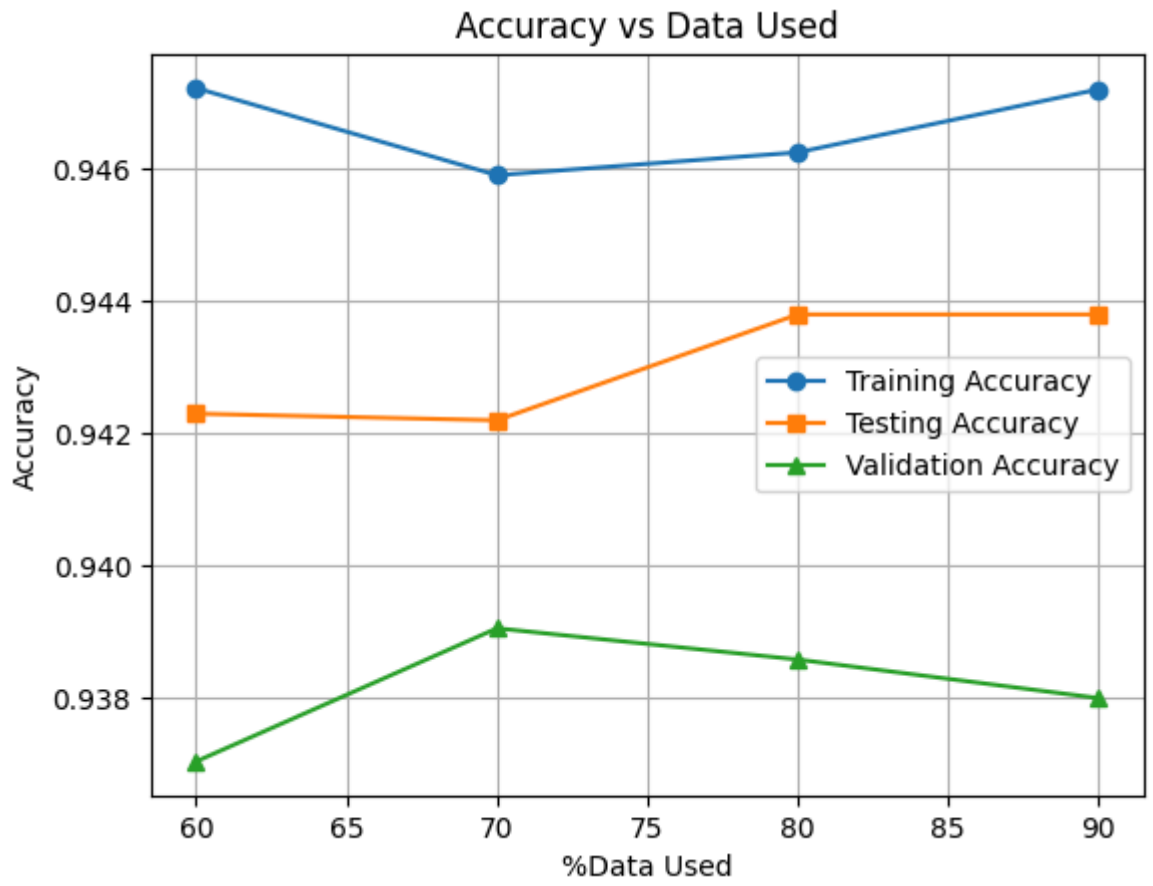
This notebook demonstrates the process of classifying handwritten digits from the MNIST dataset using different types of Support Vector Machines (SVMs) with varying data percentages. It follows the steps below:

1. **Feature Extraction (HOG)**:
    - HOG (Histogram of Oriented Gradients) is used to extract features from the images. Parameters like orientations, pixels per cell, and blocks are defined for HOG.
    - The `feature_extraction()` function reads the images, resizes them to 28x28 pixels, and extracts HOG features for both training and testing datasets.
2. **SVM Training (Linear Kernel with C = 1 and C = 10)**:
    - The SVM classifier is trained using the linear kernel with two different values of the regularization parameter CCC (1 and 10).
    - The dataset is split into training, validation, and testing subsets, with increasing percentages of data used for training (from 60% to 90%).
    - Accuracy is calculated on the training, validation, and testing sets, and the results are plotted for comparison.
3. **SVM Training (RBF Kernel with C = 1 and C = 10)**:
    - The SVM classifier is trained again using the RBF (Radial Basis Function) kernel with two different values of CCC.
    - The same percentage splits (60% to 90%) are used for training, and accuracy is computed for each subset.
    - Results are plotted to compare the performance of the RBF kernel against the linear kernel.

Accuracy tables:

SVM with Linear Kernel (C = 1)

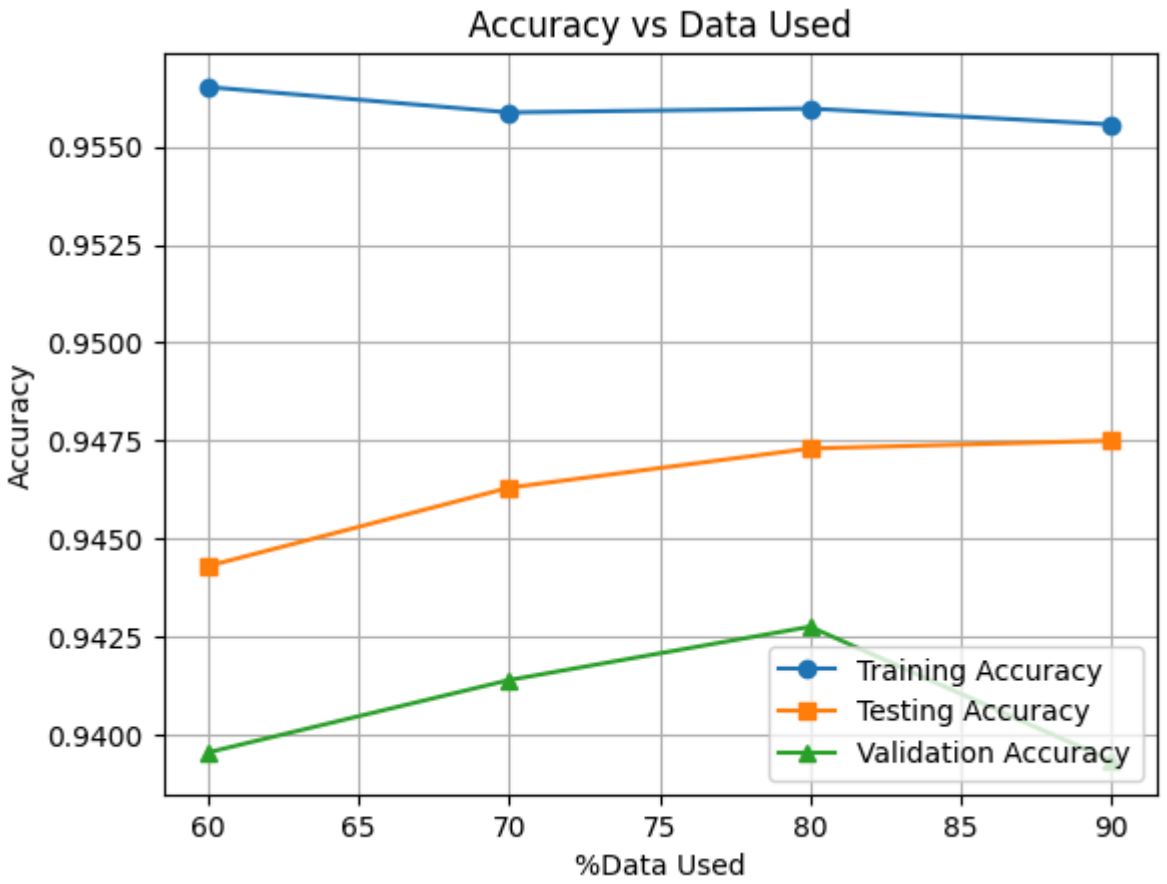
% Data Used	Training Accuracy	Validation Accuracy	Testing Accuracy
60%	94.72%	93.70%	94.23%
70%	94.59%	93.91%	94.22%
80%	94.63%	93.86%	94.38%
90%	94.72%	93.80%	94.38%



SVM with Linear Kernel (C = 10)

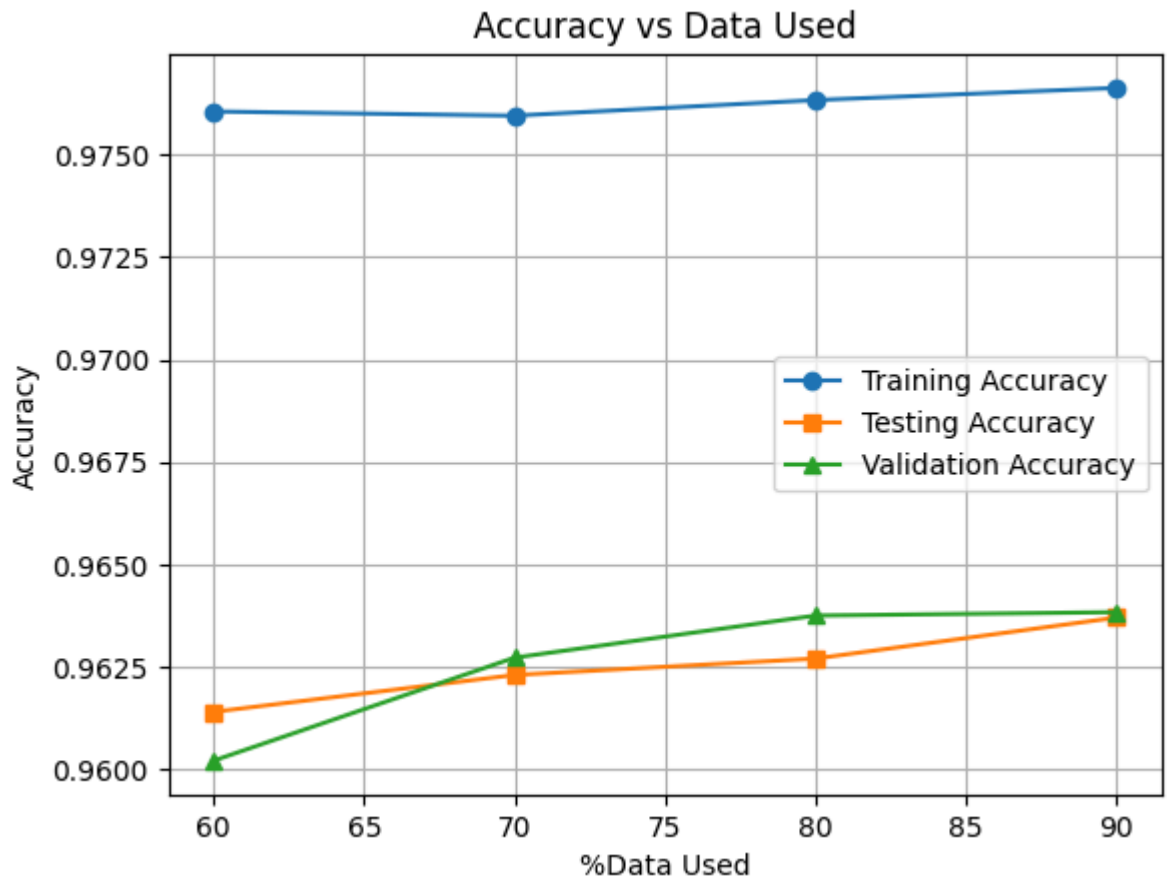
% Data Used	Training Accuracy	Validation Accuracy	Testing Accuracy
60%	95.65%	93.95%	94.43%

% Data Used	Training Accuracy	Validation Accuracy	Testing Accuracy
70%	95.59%	94.14%	94.63%
80%	95.60%	94.28%	94.73%
90%	95.56%	93.93%	94.75%



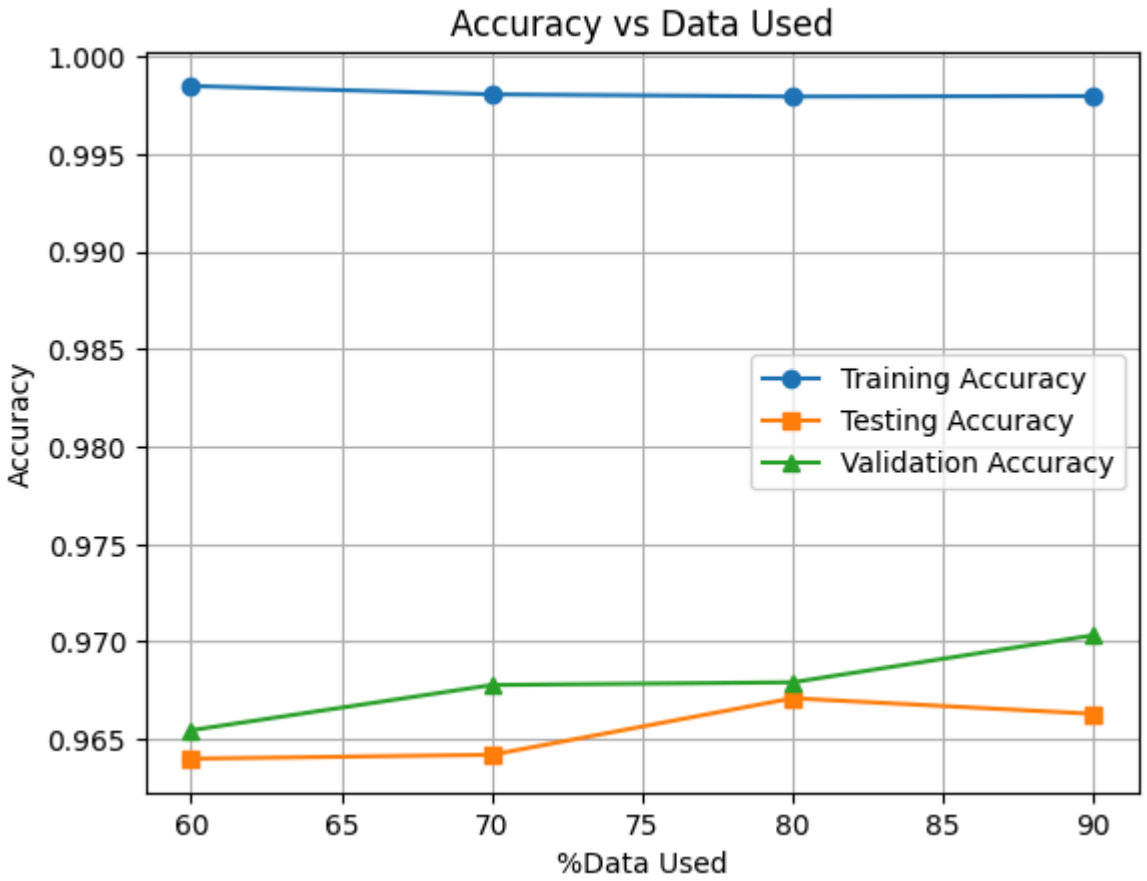
SVM with RBF Kernel (C = 1)

% Data Used	Training Accuracy	Validation Accuracy	Testing Accuracy
60%	97.61%	96.02%	96.14%
70%	97.60%	96.27%	96.23%
80%	97.63%	96.38%	96.27%
90%	97.66%	96.38%	96.37%



SVM with RBF Kernel (C = 10)

% Data Used	Training Accuracy	Validation Accuracy	Testing Accuracy
60%	99.85%	96.55%	96.40%
70%	99.81%	96.78%	96.42%
80%	99.80%	96.79%	96.71%
90%	99.80%	97.03%	96.63%



Histogram of Oriented Gradients (HOG) Parameters

The following HOG parameters were used for feature extraction in all experiments:

- **Pixels per Cell:** (8, 8)
  Each cell is composed of 8x8 pixels, ensuring a balance between feature richness and computational efficiency.

- **Cells per Block:** (2, 2)
  A block consists of 2x2 cells, which allows normalization across a larger spatial region for improved contrast handling.

- **Orientations:** 9
  Gradients are quantized into 9 orientation bins, capturing detailed edge information.

- **Block Normalization:** L2-Hys
  L2-Hys normalization is used to normalize gradient values within each block, improving robustness to illumination changes.

- **Feature Vector:** True
  The extracted features are flattened into a 1D vector for compatibility with machine learning models.