Name:

Fizza

Roll no.:

SP23-BAI-016

Teacher Name:

Sir Aksam Iftikhar

Semester:

SP24 (Semester 4)

Section:

SP23-BAI-A

Dataset Description:

Air Quality Dataset (Regression)

- Size: 9358 data points.
- Features: 12 and 1 Target Label.
- Target Variable: Nox(GT) concentration (regression task).
- Train/Test Split: 90% training, 10% testing.

Fashion-MNIST (Classification)

- Size: 60,000 training images, 10,000 test images.
- Features: 28x28 grayscale images (784 pixels).
- Classes: 10 categories.
- Train/Test Split: 60,000 training, 10,000 test images.

CIFAR-10 (Classification)

- Size: 60,000 images (50,000 training, 10,000 test).
- Features: 32x32 RGB images.
- Classes: 10.
- Train/Test Split: 50,000 training, 10,000 test images.

Model Details

Regression (ANN)

- **Model Architecture:**
    - **Input Layer:** Size = 12
    - **Hidden Layer 1:** 128 neurons, ReLU activation.
    - **Hidden Layer 2:** 64 neurons, ReLU activation.
    - **Output Layer:** 1 neuron.

Classification (ANN)

- **Model Architecture:**
- Model 1:
    - **Input Layer:** Size = 784 neurons (28x28 pixels).
    - **Hidden Layer 1:** 128 neurons, Relu activation.
    - **Hidden Layer 2:** 64 neurons, Relu activation.
    - **Output Layer:** 10 neurons, Softmax activation.

- Model 2:
    - **Input Layer:** Size = 784 neurons (28x28 pixels).
    - **Hidden Layer 1:** 256 neurons, Relu activation.
    - **Hidden Layer 2:** 128 neurons, Relu activation.
    - **Output Layer:** 10 neurons, Softmax activation.
- Model 3:
    - **Input Layer:** Size = 784 neurons (28x28 pixels).
    - **Hidden Layer 1:** 64 neurons, Relu activation.
    - **Hidden Layer 2:** 32neurons, Relu activation.
    - **Output Layer:** 10 neurons, Softmax activation.

Classification (CNN)

- **Model Architecture:**
- Model 1:
    - **Convolutional Layer 1:** 32 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Convolutional Layer 2:** 64 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Flatten Layer:** Converts 3D output to 1D.
    - **Dense Layer:** 128 neurons, ReLU activation.
    - **Dropout Layer:** 0.3
    - **Output Layer:** 10 neurons, Softmax activation.
- Model 2:
    - **Convolutional Layer 1:** 32 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Convolutional Layer 2:** 64 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Convolutional Layer 1:** 128 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Flatten Layer:** Converts 3D output to 1D.
    - **Dense Layer:** 128 neurons, ReLU activation.
    - **Dense Layer:** 64 neurons, ReLU activation.

    - **Dropout Layer:** 0.5
    - **Output Layer:** 10 neurons, Softmax activation.
- Model 3:
    - **Convolutional Layer 1:** 64 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Convolutional Layer 2:** 128 filters, 3x3 window, ReLU activation.
    - **Max Pooling:** 2x2.
    - **Flatten Layer:** Converts 3D output to 1D.
    - **Dense Layer:** 256 neurons, ReLU activation.
    - **Dropout Layer:** 0.4
    - **Output Layer:** 10 neurons, Softmax activation.

Training Configurations

Regression Model (ANN)

- **Optimizer:** SGD
- **Learning Rate:** 0.001
- **Batch Size:** 20
- **Epochs:** 50
- **Loss Function:** Mean Squared Error (MSE)

Classification Model (ANN)

- **Optimizer:** Adam
- **Learning Rate:** 0.001,0.005,0.0005
- **Epochs:** 5 per model
- **Loss Function:** Cross-Entropy Loss

Classification Model (CNN)

- **Optimizer:** Adam
- **Learning Rate:** 0.001,0.001,0.0005
- **Batch Size:** 64
- **Epochs:** 5 per model
- **Loss Function:** Categorical Cross-Entropy Loss

Performance Metrics

Regression Model (ANN)

- **MSE (Mean Squared Error):** 1.02
- **MEA (Mean Absolute Error):** 0.70

Classification Model (ANN)

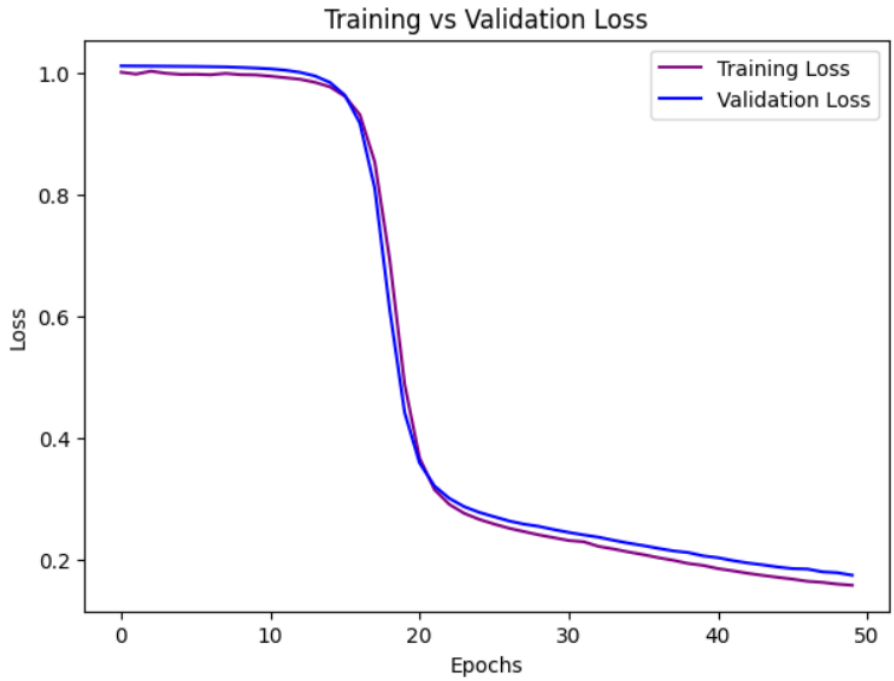
- **Model 1 Accuracy**: 0.86
- **Model 2 Accuracy**: 0.84
- **Model 3 Accuracy**: 0.87

Classification Model (CNN)

- **Model 1 Accuracy**: 0.69
- **Model 2 Accuracy**: 0.69
- **Model 3 Accuracy**: 0.72

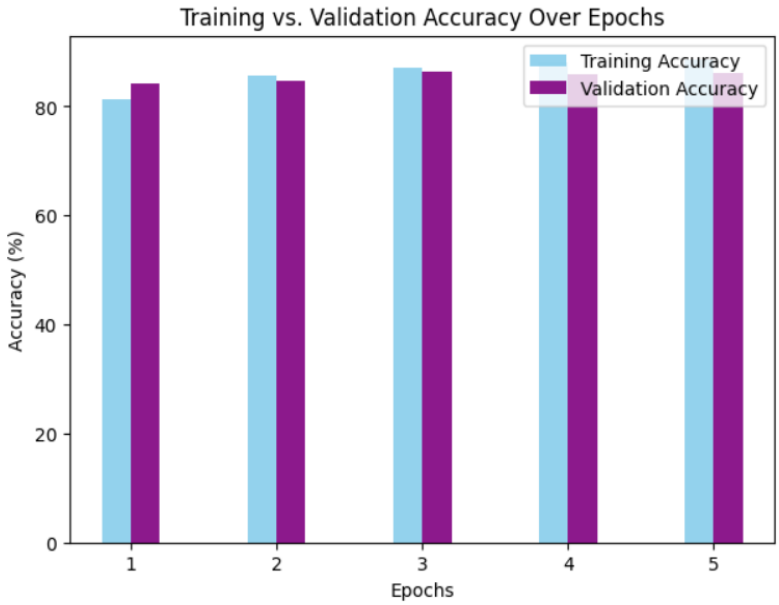
Visualizations:

Regression Plot:

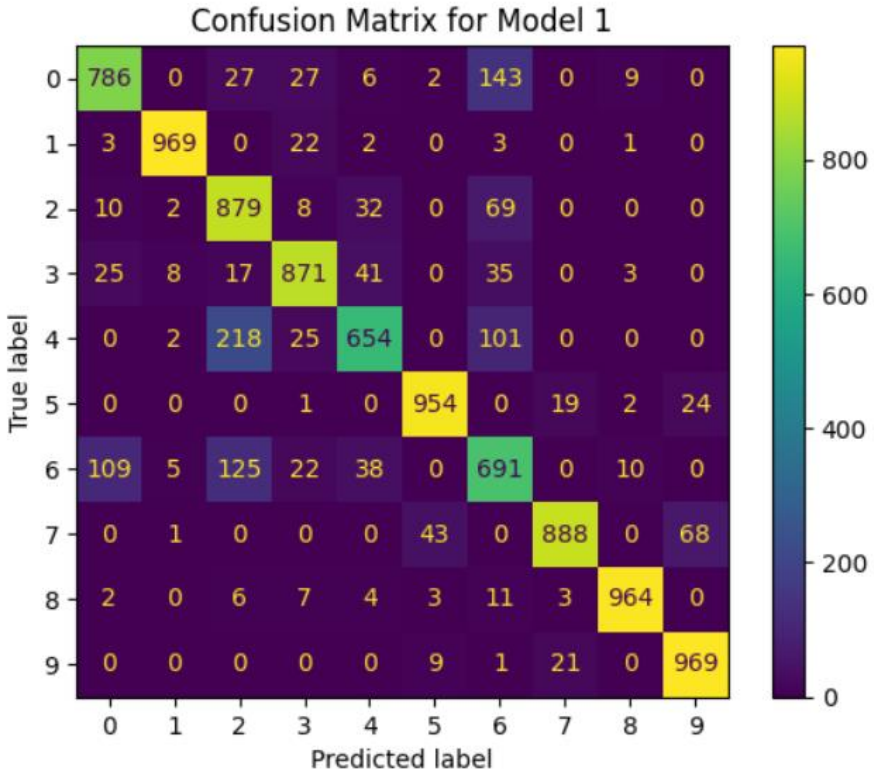


Classification (ANN):

Model 1:



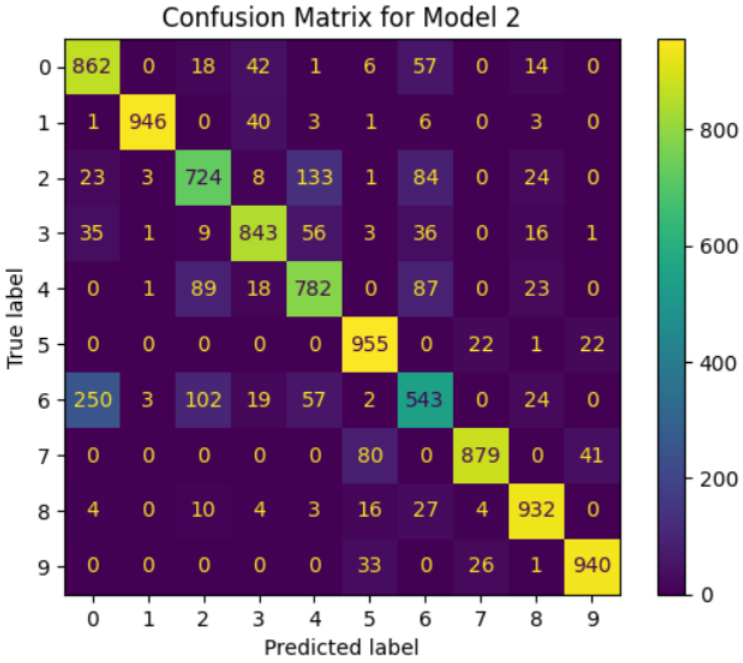
Confusion Matrix:


Confusion Matrix for Model 1
True label
Predicted label
0 786 0 27 27 6 2 143 0 9 0
1 3 969 0 22 2 0 3 0 1 0
2 10 2 879 8 32 0 69 0 0 0
3 25 8 17 871 41 0 35 0 3 0
4 0 2 218 25 654 0 101 0 0 0
5 0 0 0 1 0 954 0 19 2 24
6 109 5 125 22 38 0 691 0 10 0
7 0 1 0 0 0 43 0 888 0 68
8 2 0 6 7 4 3 11 3 964 0
9 0 0 0 0 0 9 1 21 0 969
0 1 2 3 4 5 6 7 8 9
800
600
400
200
0

Model 2:

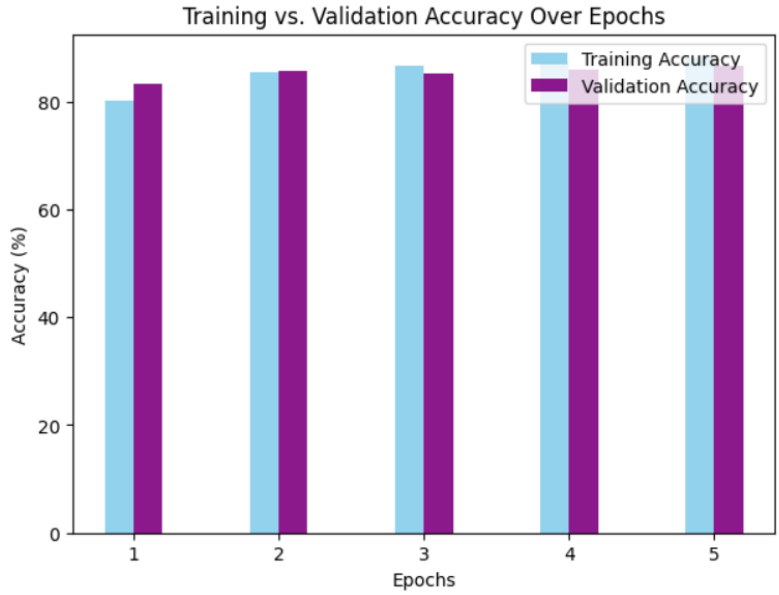

Training vs. Validation Loss Over Epochs
Loss
Epochs
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1
2
3
4
5

Confusion Matrix:

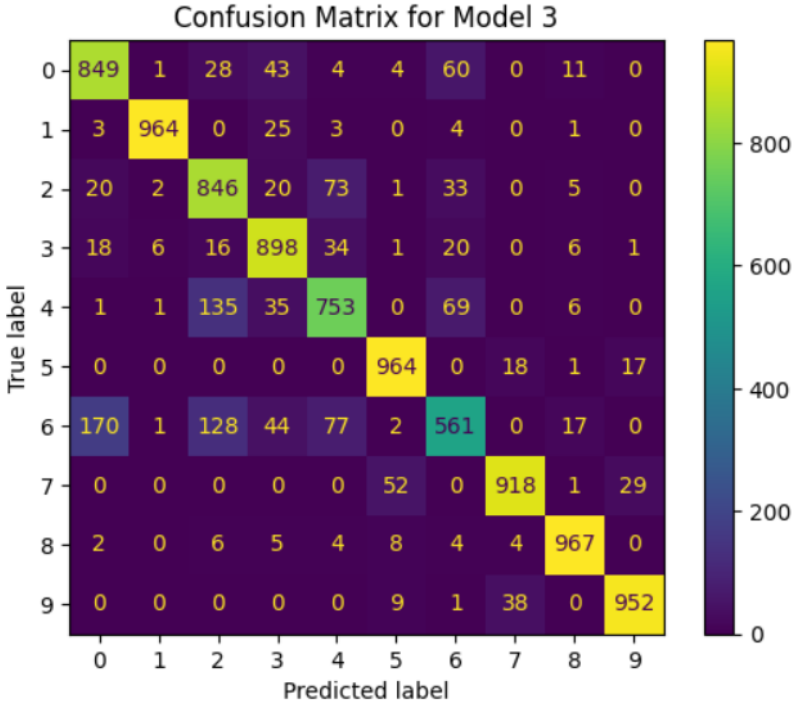


Model 3:

Epochs



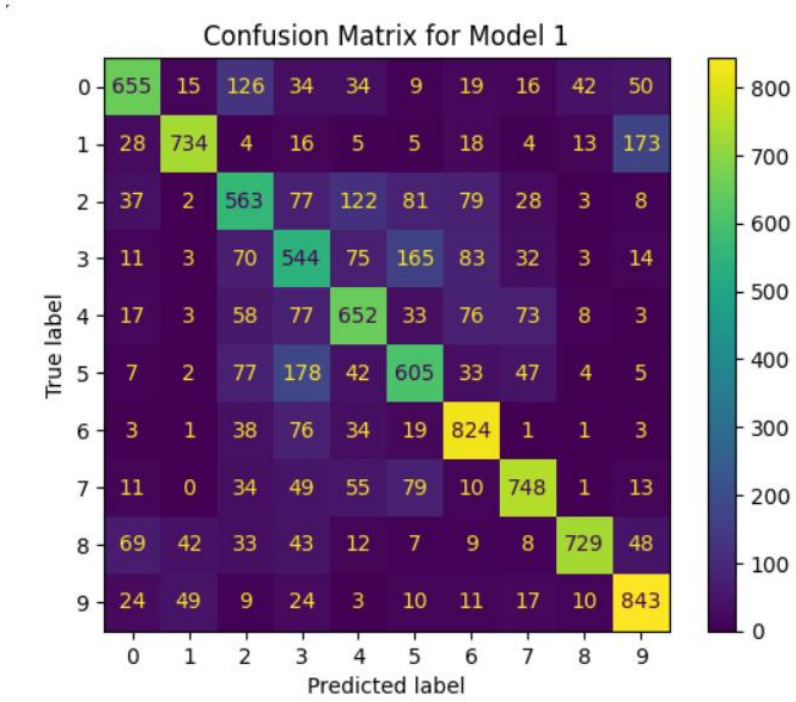
Confusion Matrix:

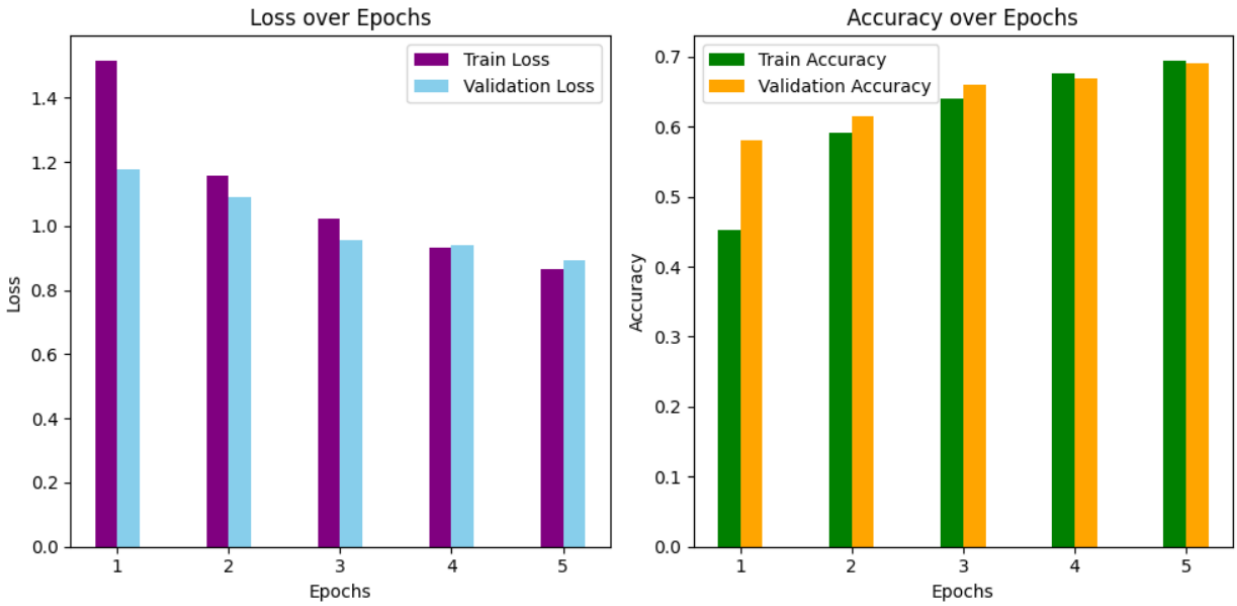


Classification (CNN):

Model 1:

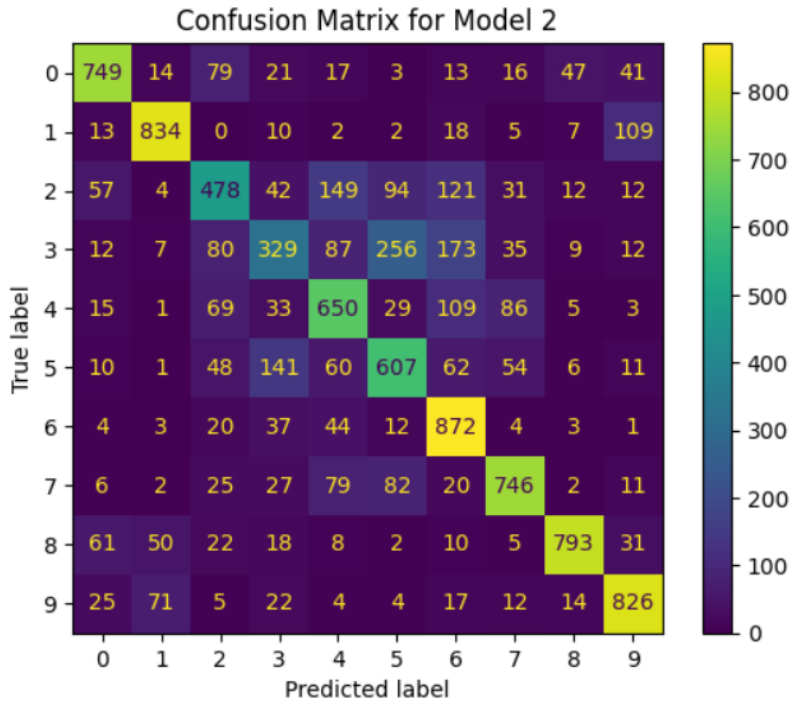
Confusion Matrix:

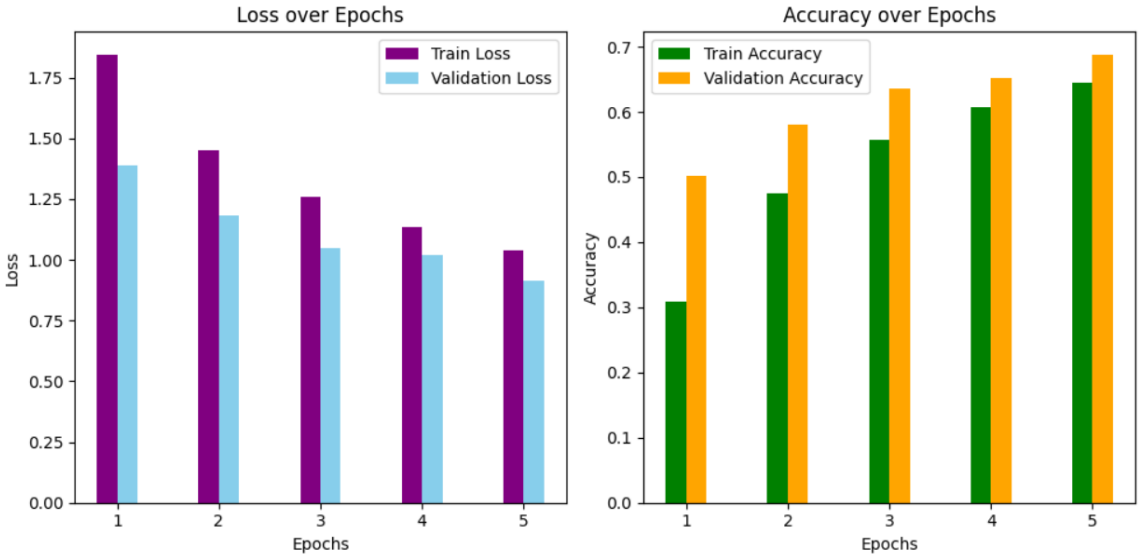




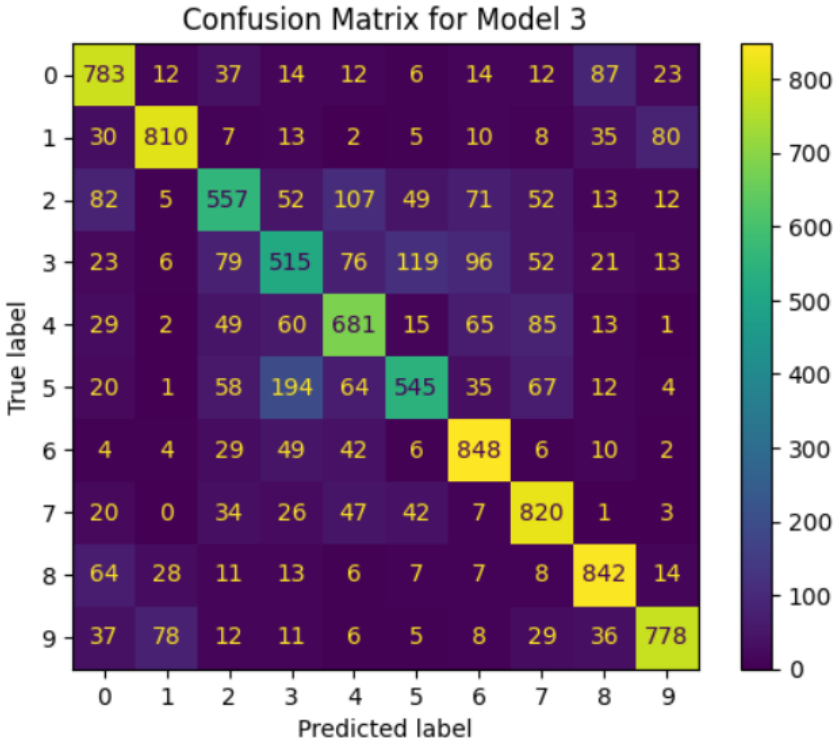
Model 2:

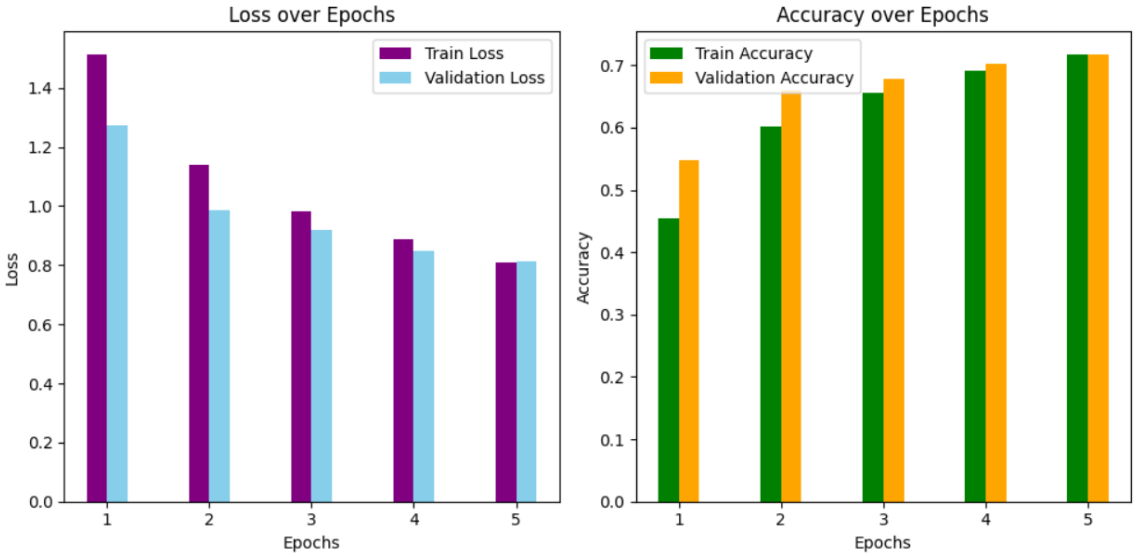
Confusion Matrix:




Loss over Epochs
Train Loss
Validation Loss
Loss
Epochs
Accuracy over Epochs
Train Accuracy
Validation Accuracy
Accuracy
Epochs

Model 3:


Confusion Matrix for Model 3
True label
Predicted label
0 783 12 37 14 12 6 14 12 87 23
1 30 810 7 13 2 5 10 8 35 80
2 82 5 557 52 107 49 71 52 13 12
3 23 6 79 515 76 119 96 52 21 13
4 29 2 49 60 681 15 65 85 13 1
5 20 1 58 194 64 545 35 67 12 4
6 4 4 29 49 42 6 848 6 10 2
7 20 0 34 26 47 42 7 820 1 3
8 64 28 11 13 6 7 7 8 842 14
9 37 78 12 11 6 5 8 29 36 778
0 1 2 3 4 5 6 7 8 9
800 700 600 500 400 300 200 100 0



Comparative Table:

Model	Dataset	Key Hyperparameters	Final Metric	Training Time
Regression (ANN)	Air Quality	LearningRate=0.001 Epoch=50	MEA:0.70 MSE:1.02	5 min
Classification (ANN)	Fashion-MNIST	LearningRate=0.0005 Epoch=5/model	Accuracy:86%	10 min
Classification (CNN)	CIFAR-10	LearningRate=0.0005 Epoch=5/model	Accuracy:72%	44 min

Strengths and Weaknesses of Each Model

Regression Model (ANN):

Strengths: The model demonstrated strong predictive power with a MAE ,MSE, indicating good performance for regression tasks.
Weaknesses: It may not generalize well to unseen data due to limited complexity and potential overfitting on small datasets.

Classification Model (ANN):

Strengths: Achieved high accuracy with a relatively simple architecture, making it computationally efficient.
Weaknesses: Struggles with misclassifications for visually similar classes due to its limited feature extraction capabilities compared to CNNs.

Classification Model (CNN):

Strengths: Good performance on image classification tasks, leveraging convolutional layers for robust feature extraction.
Weaknesses: Computationally intensive, requiring more resources for training compared to ANNs, and slightly lower accuracy than state-of-the-art CNN architectures for CIFAR-10.