CSE472
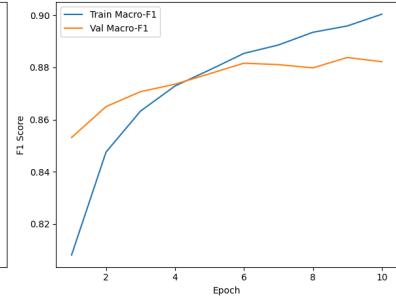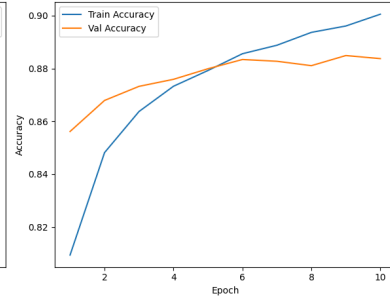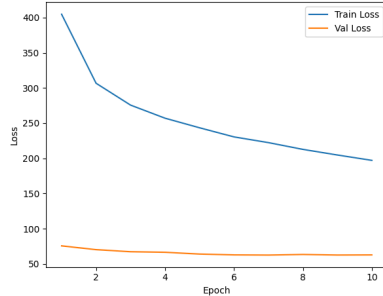# Offline-3

Wasif Jalal
1905084

FNN-1 Architecture

DenseLayer(784, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.005

Confusion Matrix - Validation Data (Model: <__main__.FNN1 object at 0x7f71f81b2b90>, LR: 0.005)

Training Loss: 0.2628, Training Accuracy: 0.9006, Training Macro-F1 Score: 0.9004
Validation Loss: 0.3344, Validation Accuracy: 0.8838, Validation Macro-F1 Score: 0.8822

FNN-1 Architecture

DenseLayer(784, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.004

Confusion Matrix - Validation Data (Model: <__main__.FNN1 object at 0x7f71f81b2b90>, LR: 0.004)

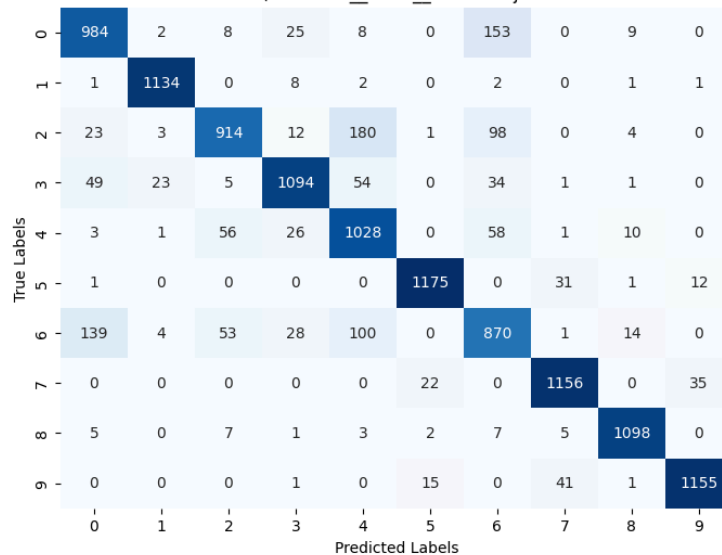Training Loss: 0.1945, Training Accuracy: 0.9258, Training Macro-F1 Score: 0.9258
Validation Loss: 0.3492, Validation Accuracy: 0.8898, Validation Macro-F1 Score: 0.8896
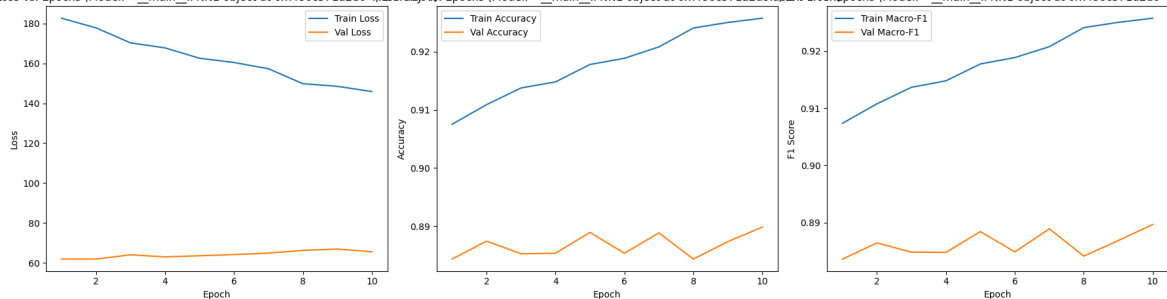
FNN-1 Architecture

DenseLayer(784, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.003

Confusion Matrix - Validation Data (Model: <__main__.FNN1 object at 0x7f71f81b2b90>, LR: 0.003)

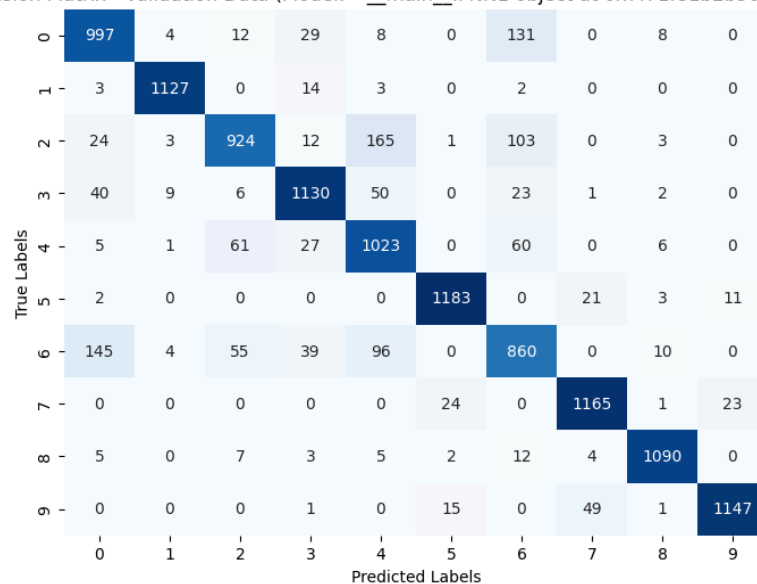Training Loss: 0.1482, Training Accuracy: 0.9434, Training Macro-F1 Score: 0.9434
Validation Loss: 0.3910, Validation Accuracy: 0.8864, Validation Macro-F1 Score: 0.8865
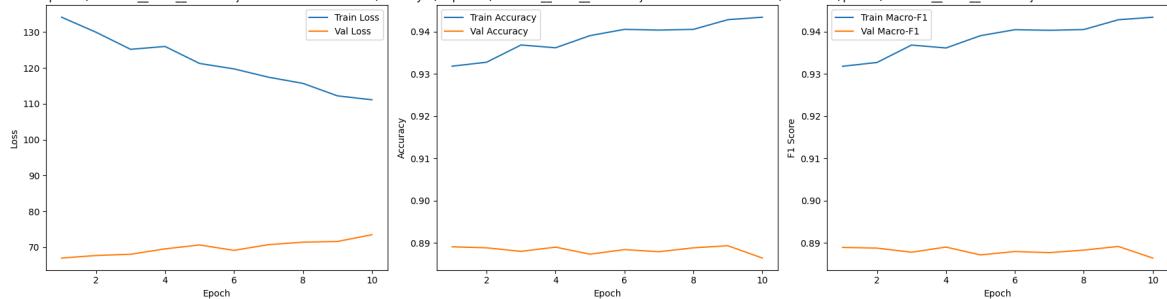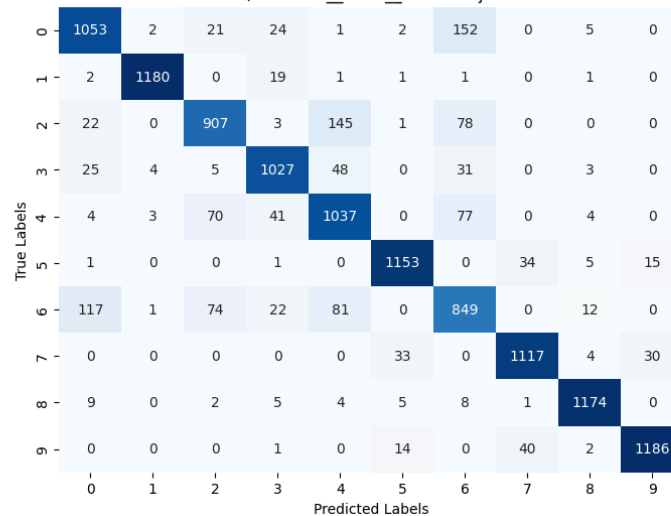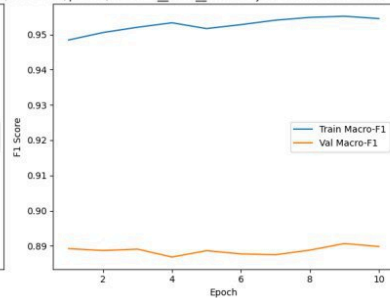
FNN-1 Architecture

DenseLayer(784, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.002

Confusion Matrix - Validation Data (Model: <__main__.FNN1 object at 0x7f86c571a2d0>, LR: 0.002)

Training Loss: 0.1170, Training Accuracy: 0.9545, Training Macro-F1 Score: 0.9545
Validation Loss: 0.4282, Validation Accuracy: 0.8902, Validation Macro-F1 Score: 0.8898

FNN-2 Architecture

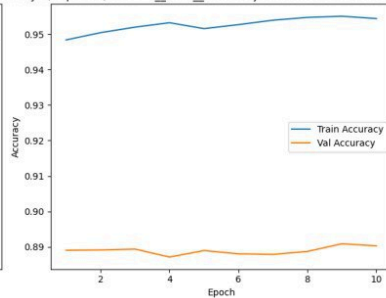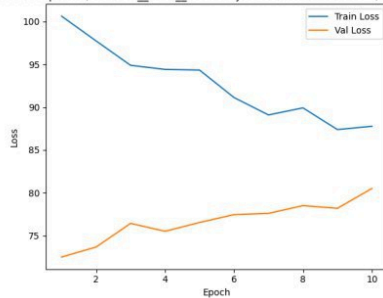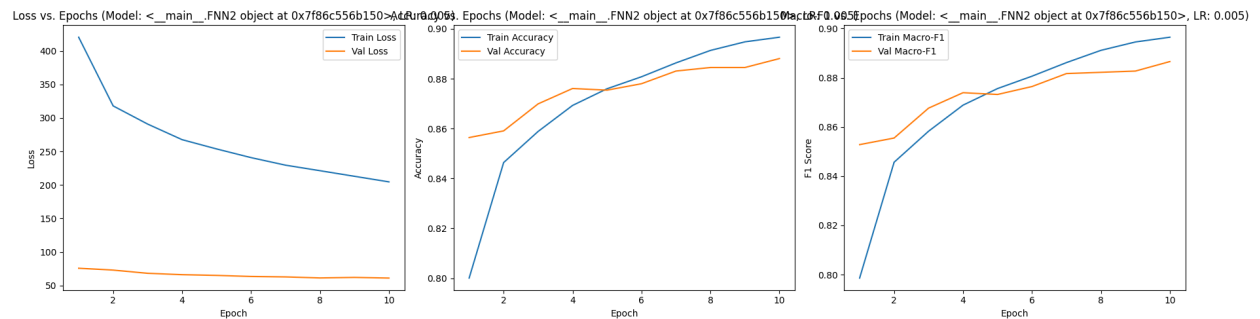DenseLayer(784, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.005

Confusion Matrix - Validation Data (Model: <__main__.FNN2 object at 0x7f71f8913990>, LR: 0.005)

Training Loss: 0.2728, Training Accuracy: 0.8966, Training Macro-F1 Score: 0.8965
Validation Loss: 0.3255, Validation Accuracy: 0.8881, Validation Macro-F1 Score: 0.8866

FNN-2 Architecture

DenseLayer(784, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.004

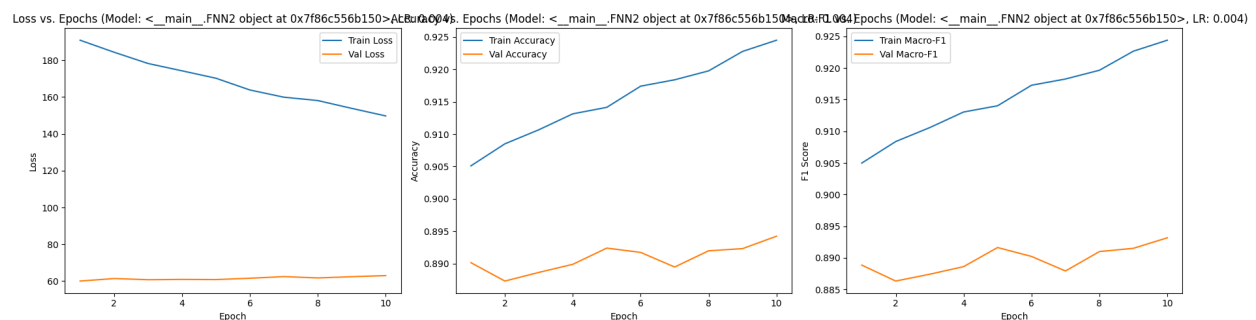Training Loss: 0.1997, Training Accuracy: 0.9245, Training Macro-F1 Score: 0.9244
Validation Loss: 0.3352, Validation Accuracy: 0.8942, Validation Macro-F1 Score: 0.8932

FNN-2 Architecture

DenseLayer(784, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.003

Confusion Matrix - Validation Data (Model: <__main__.FNN2 object at 0x7f71fd7499d0>, LR: 0.003)

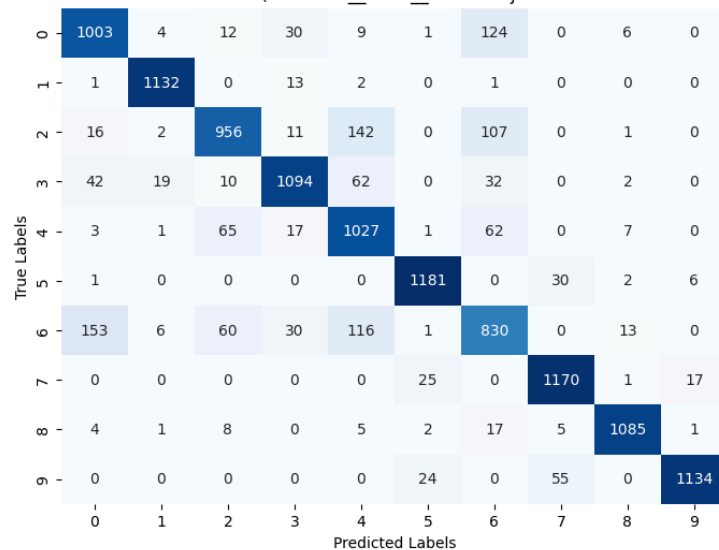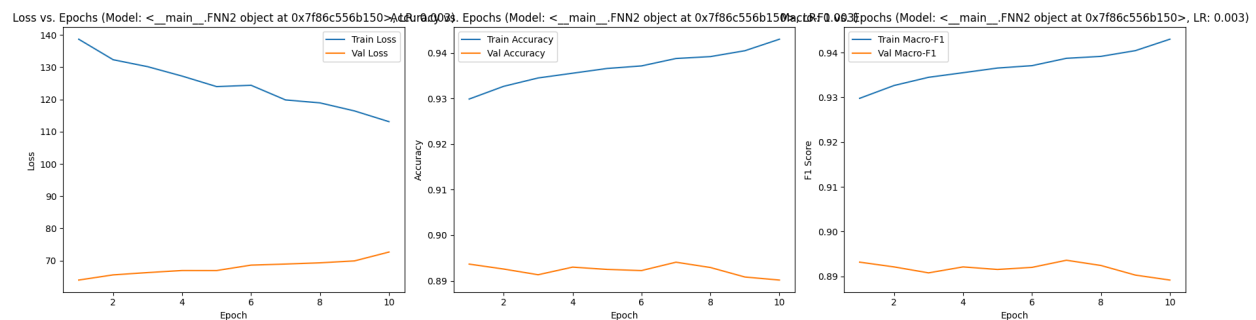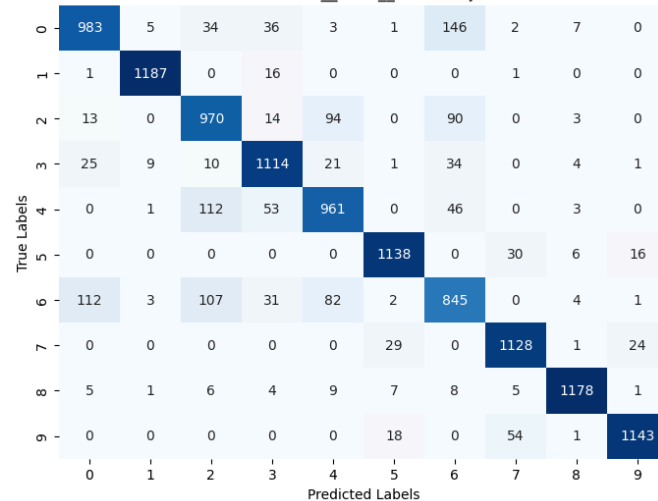Training Loss: 0.1508, Training Accuracy: 0.9430, Training Macro-F1 Score: 0.9430
Validation Loss: 0.3864, Validation Accuracy: 0.8902, Validation Macro-F1 Score: 0.8892

FNN-2 Architecture

DenseLayer(784, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.002

Training Loss: 0.1172, Training Accuracy: 0.9552, Training Macro-F1 Score: 0.9552
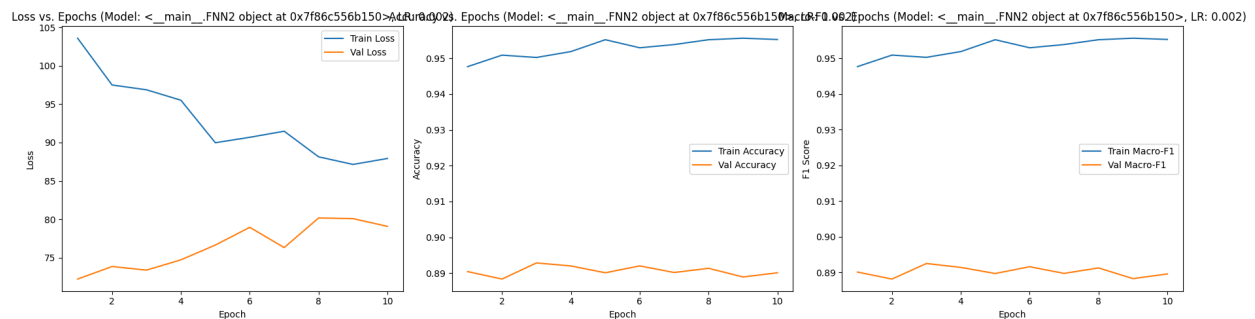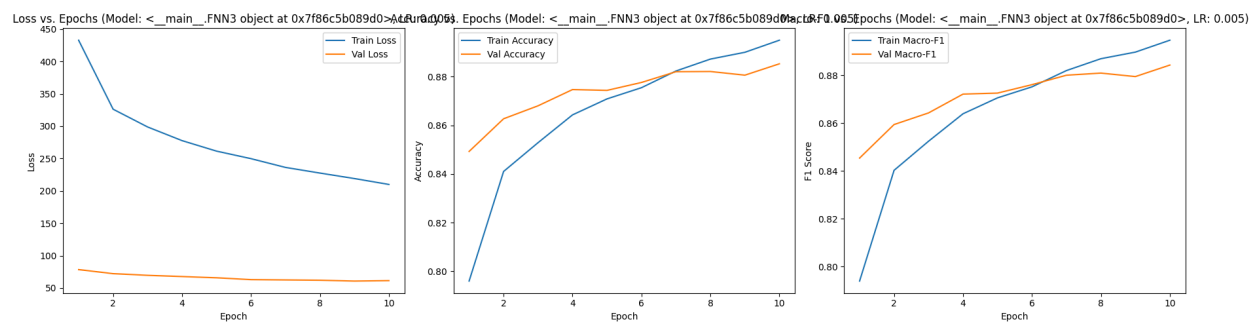Validation Loss: 0.4207, Validation Accuracy: 0.8901, Validation Macro-F1 Score: 0.8895

FNN-3 Architecture

DenseLayer(784, 512),
BatchNorm(512),
ReLU(),
Dropout(0.1),
DenseLayer(512, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.005

Confusion Matrix - Validation Data (Model: <__main__.FNN3 object at 0x7f71f82e4790>, LR: 0.005)

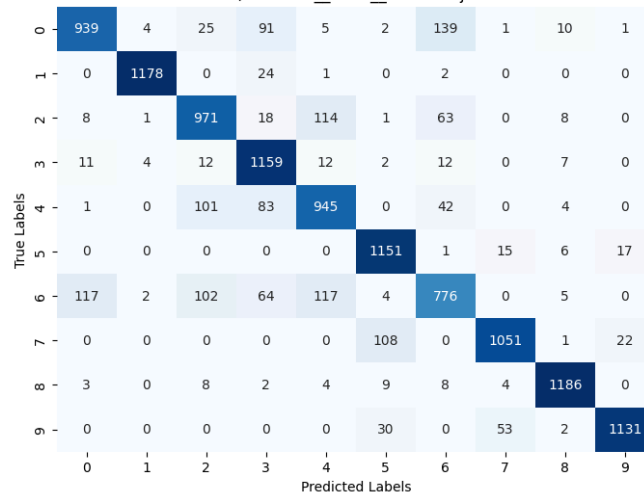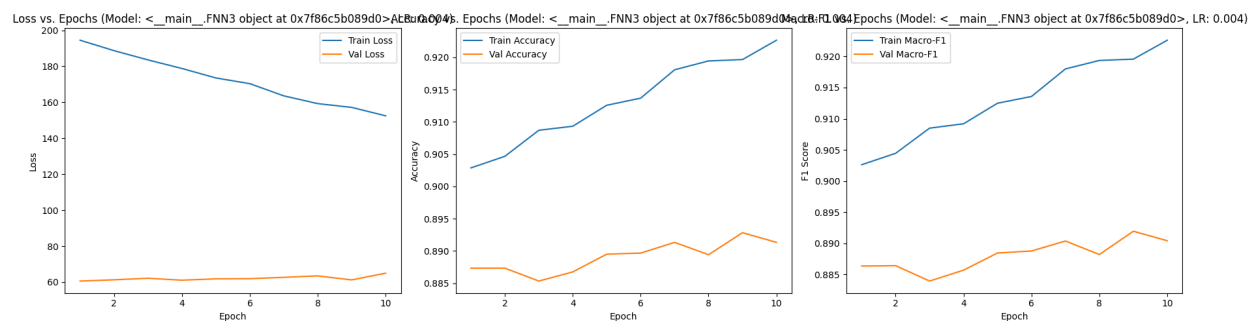Training Loss: 0.2800, Training Accuracy: 0.8949, Training Macro-F1 Score: 0.8947
Validation Loss: 0.3267, Validation Accuracy: 0.8852, Validation Macro-F1 Score: 0.8843

FNN-3 Architecture

DenseLayer(784, 512),
BatchNorm(512),
ReLU(),
Dropout(0.1),
DenseLayer(512, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.004

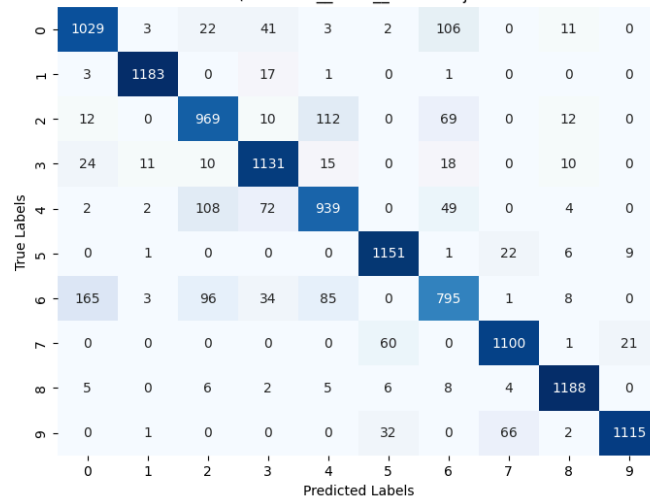Training Loss: 0.2033, Training Accuracy: 0.9227, Training Macro-F1 Score: 0.9226
Validation Loss: 0.3457, Validation Accuracy: 0.8913, Validation Macro-F1 Score: 0.8904

FNN-3 Architecture

DenseLayer(784, 512),
BatchNorm(512),
ReLU(),
Dropout(0.1),
DenseLayer(512, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.003

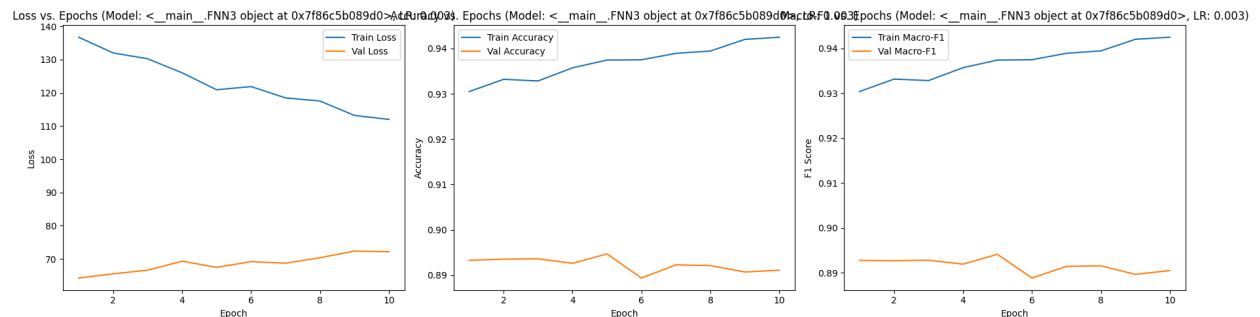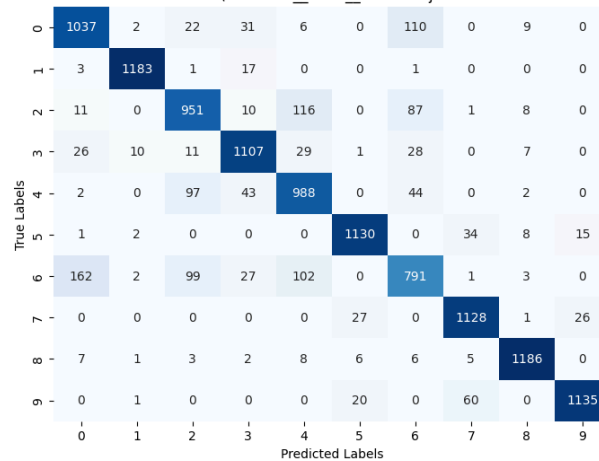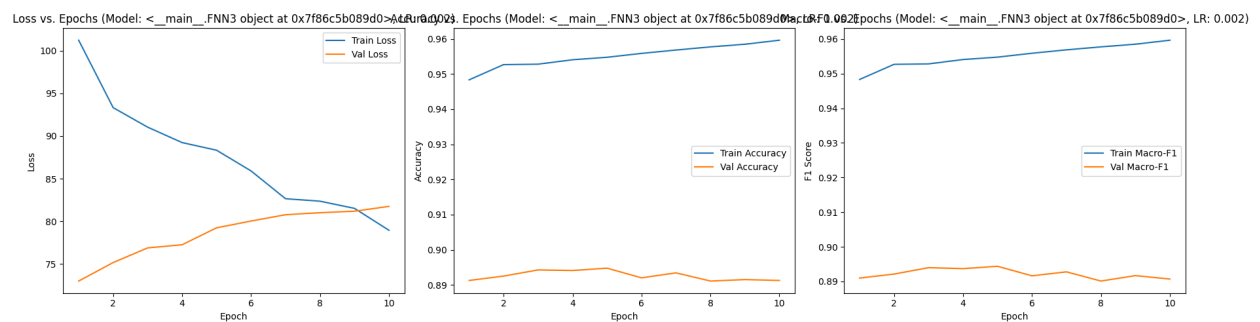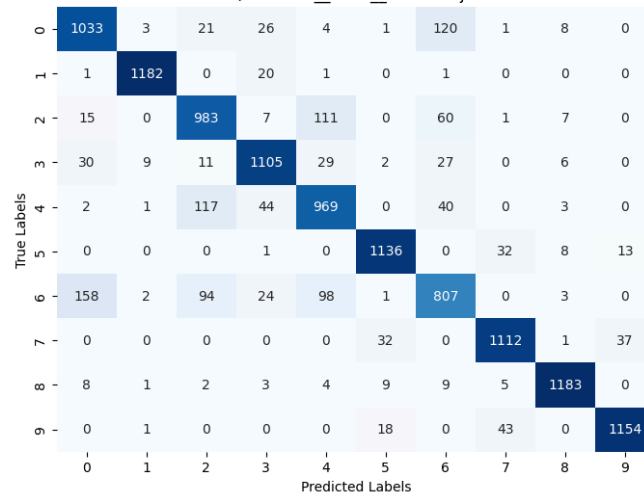Training Loss: 0.1494, Training Accuracy: 0.9425, Training Macro-F1 Score: 0.9425
Validation Loss: 0.3840, Validation Accuracy: 0.8911, Validation Macro-F1 Score: 0.8905

FNN-3 Architecture

DenseLayer(784, 512),
BatchNorm(512),
ReLU(),
Dropout(0.1),
DenseLayer(512, 256),
BatchNorm(256),
ReLU(),
Dropout(0.1),
DenseLayer(256, 128),
BatchNorm(128),
ReLU(),
Dropout(0.1),
DenseLayer(128, 64),
BatchNorm(64),
ReLU(),
Dropout(0.1),
DenseLayer(64, 10),
Softmax()

Learning Rate 0.002

Confusion Matrix - Validation Data (Model: <__main__.FNN3 object at 0x7f71f82e4790>, LR: 0.002)

Training Loss: 0.1053, Training Accuracy: 0.9596, Training Macro-F1 Score: 0.9597
Validation Loss: 0.4349, Validation Accuracy: 0.8912, Validation Macro-F1 Score: 0.8907

Best Model

From the above analysis it is observed that FNN-2 with learning rate 0.004 performs best on the validation test, so we use it to predict on the independent test set and get the following results:

Training Loss: 0.2360, Training Accuracy: 0.9116, Training Macro-F1 Score: 0.9114
Test Loss: 0.3031, Test Accuracy: 0.9068, Test Macro-F1 Score: 0.9063