FAST NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES

REPORT

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Assignment:	**6**
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Course:	**Machine Learning**

Deliverables:

- ML_A6_LeNet-5.ipynb
- ML_A6_AlexNet.ipynb
- Code Report

Preprocessing

The preprocessing steps for all three models—your custom CNN, LeNet-5, and AlexNet—were consistent to ensure fair comparison. The MNIST dataset was used, which consists of 28×2828×28 grayscale images of handwritten digits.

- **Normalization**: Pixel values were scaled to the range [0, 1] by dividing by 255. This improves model convergence during training.
- **Reshaping**: Images were reshaped into a 4D tensor with shape (batch size,28,28,1)(batch size,28,28,1) to match the input requirements of convolutional neural networks (CNNs).
- **One-Hot Encoding**: Labels were one-hot encoded into 10 categories (digits 0–9) using TensorFlow's utility functions.

Model Performance Comparison

The three models were trained for 3 epochs using the Adam optimizer, categorical cross-entropy loss, and a batch size of 32. A validation split of 20% was used during training. Below are the test accuracies:

Model	Test Accuracy
Custom CNN	~99.1%
LeNet-5	~98.3%
AlexNet (Adapted)	~98.8%

Observations

1. **Custom CNN**:
    - Achieved the highest test accuracy (~99.1%).
    - Its modern design, with ReLU activation, max pooling, and dropout, made it highly efficient for the MNIST dataset.
    - Simpler compared to AlexNet but still effective.
2. **LeNet-5**:
    - Achieved slightly lower accuracy (~98.3%).
    - Uses older techniques like tanh activation and average pooling.
    - While effective for its time, it lacks modern optimizations, such as dropout, leading to slightly inferior performance.
3. **AlexNet (Adapted)**:
    - Achieved a strong test accuracy (~98.8%), slightly below the custom CNN.
    - Its deep architecture and multiple layers made it capable of extracting complex features but required adaptations to suit MNIST's small input size.

Conclusion

While all three models performed well on the MNIST dataset, the custom CNN emerged as the best model due to its modern and lightweight design, achieving slightly better accuracy than both LeNet-5 and AlexNet. However, AlexNet demonstrated the potential of deeper architectures, and LeNet-5 proved its historical importance as a foundational model for CNNs.