LAB 3: STUDENT WORKSHEET

# Convolutional Neural Networks (CNN)

**Name:**  **Student ID:**  **Date:**

# PART 1: BASIC CNN PERFORMANCE

Record the performance metrics for the basic CNN models on MNIST and CIFAR-10.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Dataset** | **Test Accuracy (%)** | **Training Time (s)** | **Inference Time (ms)** | **Total Parameters** |
| MNIST |  |  |  |  |
| CIFAR-10 |  |  |  |  |
| C |  |  |  | C |

What are the key differences in performance between the two datasets? Why?

# PART 2: CNN ARCHITECTURE EXPLORATION

Record the performance metrics for different CNN architectures on MNIST.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Architecture** | **Test Accuracy (%)** | **Training Time (s)** | **Inference Time (ms)** | **Parameters** |
| ShallowCNN |  |  |  |  |
| DeepCNN |  |  |  |  |
| WideCNN |  |  |  |  |
| TinyCNN |  |  |  |  |
| C |  |  |  | C |

Record the performance metrics for different filter sizes on MNIST.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Filter Configuration** | **Test Accuracy (%)** | **Training Time (s)** | **Inference Time (ms)** | **Parameters** |
| SmallFilters (2×2) |  |  |  |  |
| LargeFilters (5×5) |  |  |  |  |
| MixedFilters |  |  |  |  |
| C |  |  |  | C |

Based on your results:

1. How does network depth affect performance and efficiency?
2. How does network width affect performance and efficiency?
3. How do filter sizes affect performance and learned features?

# PART 3: TRANSFER LEARNING

Record the performance metrics for transfer learning models on CIFAR-10.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **Test Accuracy**  **(%)** | **Training**  **Time (s)** | **Inference Time**  **(ms)** | **Trainable**  **Parameters** | **Total**  **Parameters** |
| Basic CNN |  |  |  |  |  |
| MobileNetV2  Transfer |  |  |  |  |  |
| MobileNetV2 Fine-  tuned |  |  |  |  |  |
| C |  |  |  |  | C |

How did transfer learning affect:

1. Model accuracy:
2. Training time:
3. Parameter efficiency:

# PART 4: CNN VS FCNN COMPARISON

Compare the best CNN model from this lab with the best FCNN model from Lab 2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model**  **Type** | **Test Accuracy**  **(%)** | **Training Time**  **(s)** | **Inference Time**  **(ms)** | **Parameters** | **Accuracy/Million**  **Params** |
| Best FCNN |  |  |  |  |  |
| Best CNN |  |  |  |  |  |
| C |  |  |  |  | C |

What are the key advantages of CNNs over FCNNs for image classification?

# PART 5: EFFICIENCY METRICS

Record the efficiency metrics for the best models according to different criteria.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Criteria** | **Best**  **Model** | **Accuracy**  **(%)** | **Inference Time**  **(ms)** | **Parameters** | **Accuracy/Million**  **Params** |
| Highest Accuracy |  |  |  |  |  |
| Fastest Inference |  |  |  |  |  |
| Most Parameter-  Efficient |  |  |  |  |  |
| C |  |  |  |  | C |

# PART 6: ANALYSIS QUESTIONS

1. How does the parameter sharing in CNN layers contribute to efficiency compared to FCNNs?
2. For resource-constrained mobile devices, which CNN architecture would you recommend and why?
3. When would transfer learning be most beneficial? When might it not be worth the additional complexity?
4. Based on your experiments, what is the relationship between model complexity (parameters) and accuracy in CNNs?

# PART 7: REFLECTION

Write a short reflection (100-150 words) on what you learned about CNNs and their hardware implications.

# PART 8: FEATURE VISUALIZATION (OPTIONAL)

Describe what you observed in the filter and feature map visualizations:

1. What patterns did you notice in the first layer filters?
2. How did the feature maps change in deeper layers?
3. How did visualizations differ between architectures?

# INSTRUCTOR COMMENTS

Grade: /