# LAB 2: STUDENT WORKSHEET

## Fully Connected Neural Networks (FCNN)

**Name:** _____

**Student ID:** _____

**Date:** _____

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## PART 1: NETWORK DEPTH EXPERIMENT

Record the performance metrics for FCNNs with different depths (all with 128 neurons per layer).

| Number of Hidden Layers | Test Accuracy (%) | Training Time (s) | Inference Time (ms) | Total Parameters |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

Based on your results, what is the relationship between network depth and:

- Model accuracy? _____
- Training time? _____
- Inference time? _____

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## PART 2: NETWORK WIDTH EXPERIMENT

Record the performance metrics for FCNNs with different widths (all with 2 hidden layers).

| Hidden Layer Width | Test Accuracy (%) | Training Time (s) | Inference Time (ms) | Total Parameters |
|---|---|---|---|---|
| 64 | | | | |
| 128 | | | | |
| 256 | | | | |
| 512 | | | | |

Based on your results, what is the relationship between network width and:

- Model accuracy? _____
- Training time? _____

- Parameter count? _____

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## PART 3: ACTIVATION FUNCTIONS

Record the performance metrics for FCNNs with different activation functions (all with 2 hidden layers, 128 neurons each).

| Activation Function | Test Accuracy (%) | Training Time (s) | Epochs to Converge | Inference Time (ms) |
|---|---|---|---|---|
| ReLU | | | | |
| Sigmoid | | | | |
| Tanh | | | | |
| ELU | | | | |

Which activation function:

- Achieved the highest accuracy? _____
- Converged the fastest? _____
- Had the fastest inference time? _____

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## PART 4: REGULARIZATION (DROPOUT)

Record the performance metrics for FCNNs with different dropout rates (all with 2 hidden layers, 128 neurons each, ReLU activation).

| Dropout Rate | Test Accuracy (%) | Training Time (s) | Epochs to Converge | Training-Validation Gap |
|---|---|---|---|---|
| 0.0 | | | | |
| 0.2 | | | | |
| 0.4 | | | | |
| 0.6 | | | | |

How did increasing dropout rate affect:

- Model generalization (training-validation gap)? _____
- Training time? _____
- Test accuracy? _____

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## PART 5: MEMORY PROFILING

Record the memory usage for models with different widths.

| Hidden Layer Width | Parameters | Baseline Memory (MB) | Peak Memory (MB) | Memory Increase (MB) |
|---|---|---|---|---|
| 64 | | | | |
| 128 | | | | |
| 256 | | | | |
| 512 | | | | |

What is the relationship between model size and memory usage? Is it linear?

## PART 6: DATASET COMPARISON

Compare the performance of a standard FCNN (2 hidden layers, 128 neurons each, ReLU activation, 0.2 dropout) on both datasets.

| Dataset | Test Accuracy (%) | Training Time (s) | Epochs to Converge |
|---|---|---|---|
| MNIST | | | |
| Fashion MNIST | | | |

Why do you think there is a difference in performance between the two datasets?

## PART 7: EFFICIENCY METRICS

Record the efficiency metrics for the best performing models.

| Model Architecture | Accuracy/Million Parameters | Parameters/Second (training) |
|---|---|---|
| Best Accuracy Model: | | |
| Fastest Training Model: | | |
| Fastest Inference Model: | | |
| Most Parameter-Efficient: | | |

## PART 8: ANALYSIS QUESTIONS

1. Which network architecture would you recommend for deployment on a mobile device? Why?

2. How does increasing network complexity (depth and width) affect the trade-off between accuracy and computational efficiency?

3. What hyperparameter had the most significant impact on model performance? Explain why.

4. Based on your experiments, describe the ideal FCNN architecture for the MNIST dataset that balances accuracy and computational efficiency.

## INSTRUCTOR COMMENTS

Grade: _____ / _____