Multilayer Perceptron

Comprehensive Demo and Analysis

From-scratch NumPy implementation with backpropagation,
mini-batch gradient descent, and multiple activation functions.

Seed: 42 | NumPy only | Validated against sklearn

Generated by demo.py

SUMMARY OF EXAMPLES

1. XOR Problem
   The classic nonlinear classification problem that proves hidden layers
   can learn representations where classes become linearly separable.

2. Decision Boundary Visualization
   Shows how MLP complexity (width and depth) affects the ability to
   carve nonlinear decision boundaries on moons and circles datasets.

3. Training Convergence
   Demonstrates the effect of learning rate and architecture depth
   on convergence speed and final loss.

4. Weight Initialization Comparison
   He vs Xavier initialization -- activation variance stability across
   layers and impact on training dynamics.

5. Sklearn Comparison
   Validates our from-scratch MLP against sklearn's MLPClassifier,
   showing comparable accuracy on the moons dataset.

6. Real Dataset -- Breast Cancer
   30-feature medical dataset with multiple architecture sizes.
   Demonstrates practical classification performance.

7. Activation Function Comparison
   ReLU vs GELU vs SiLU vs Tanh -- same architecture, different
   activations, comparing convergence and decision boundaries.

8. Mini-batch vs Full-batch
   Compares SGD (batch=1), mini-batch (32, 128), and full-batch
   training to show convergence noise vs speed tradeoffs.

XOR Problem -- Classic Nonlinear Classification

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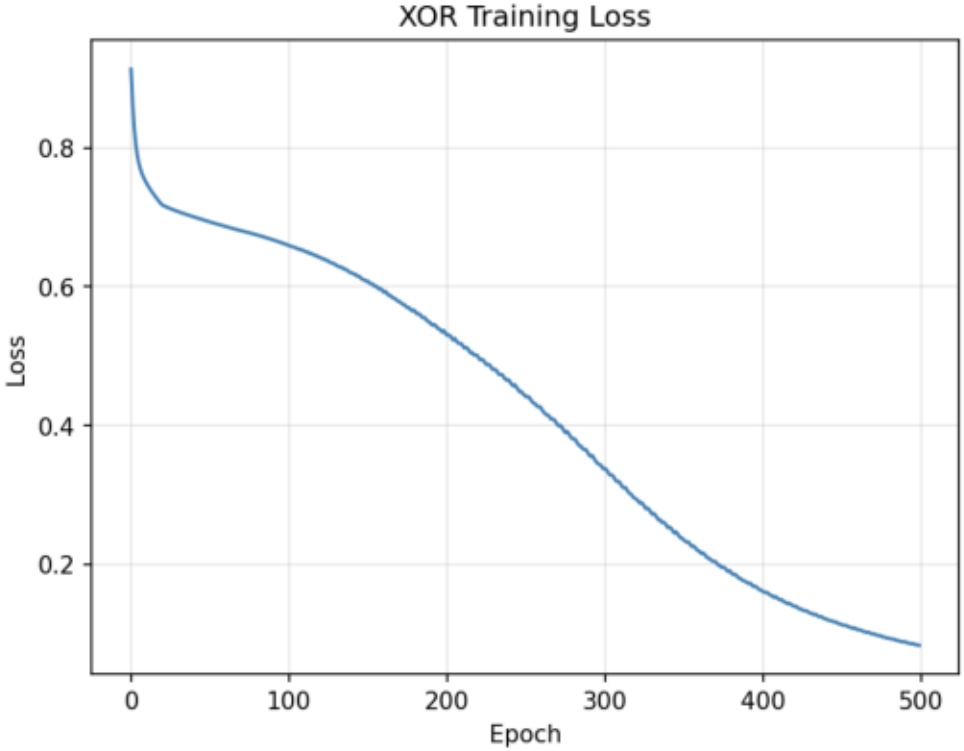
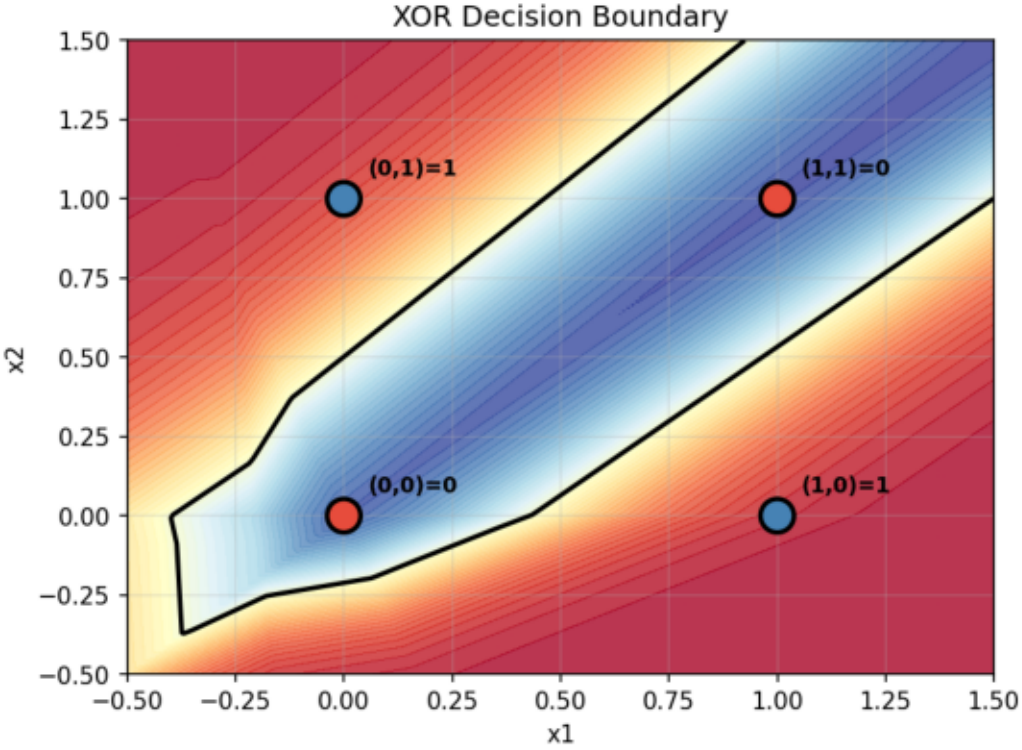
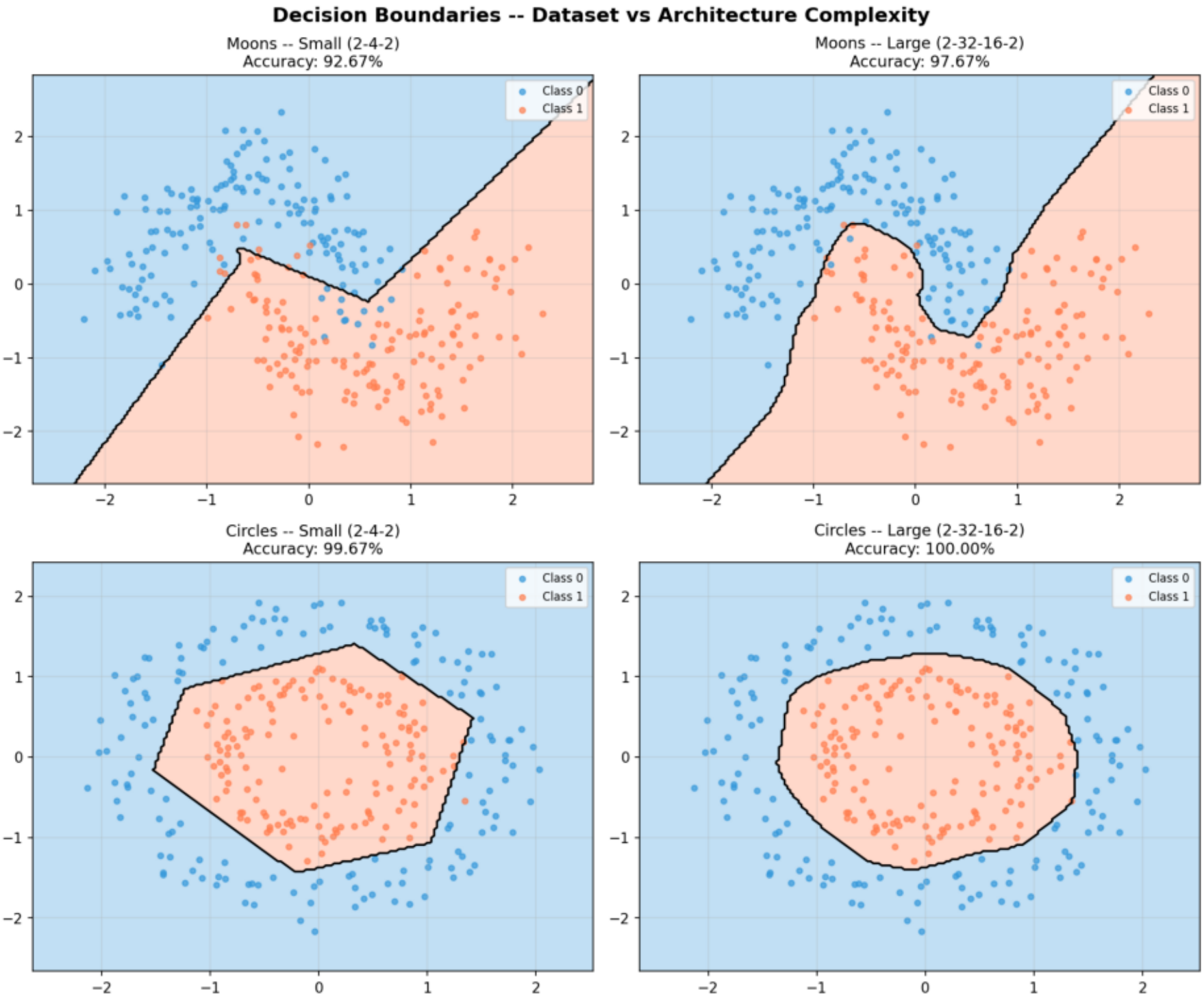
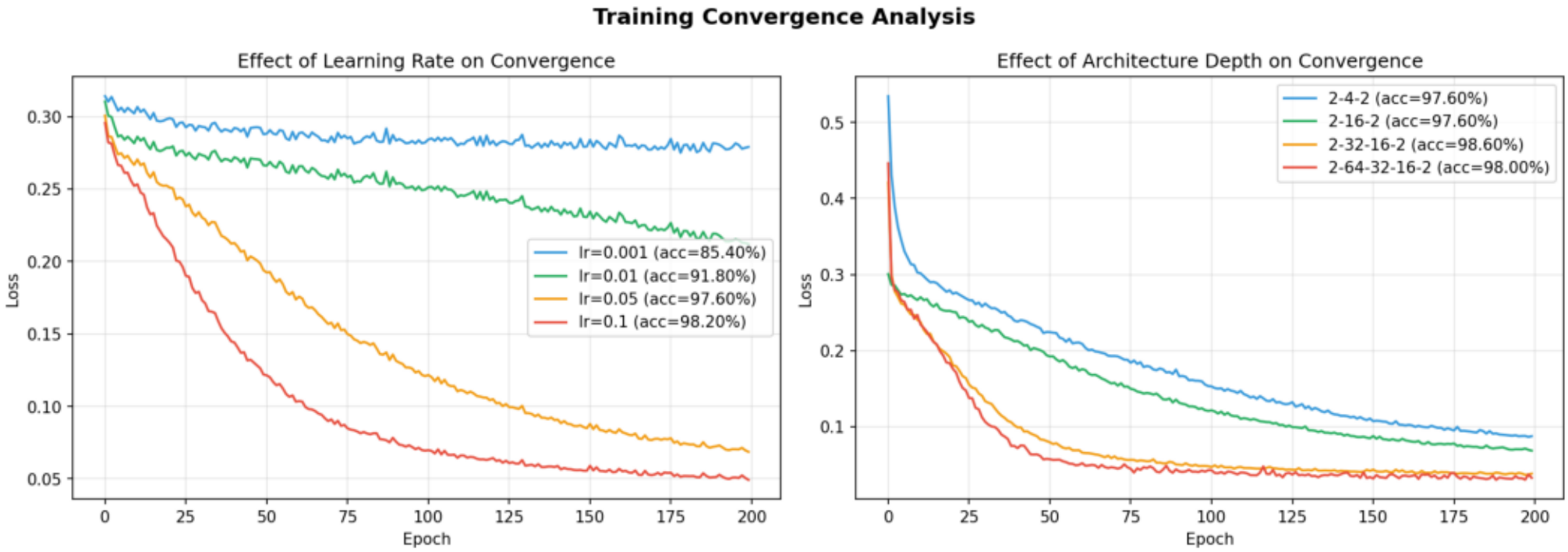




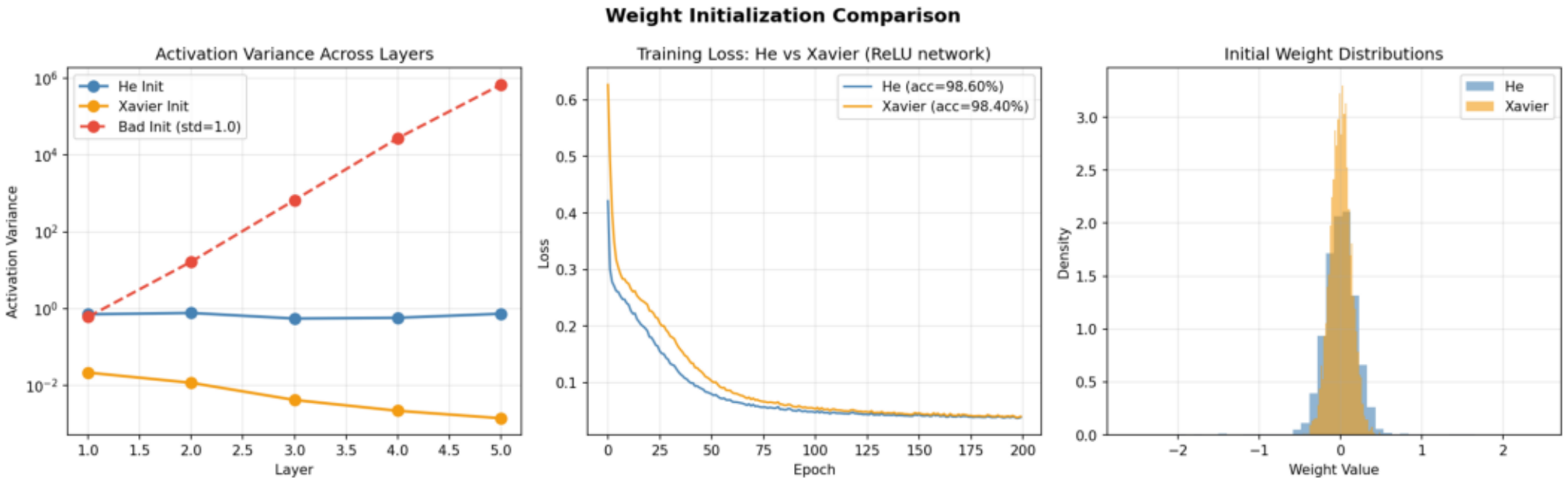
Decision Boundaries -- Dataset vs Architecture Complexity



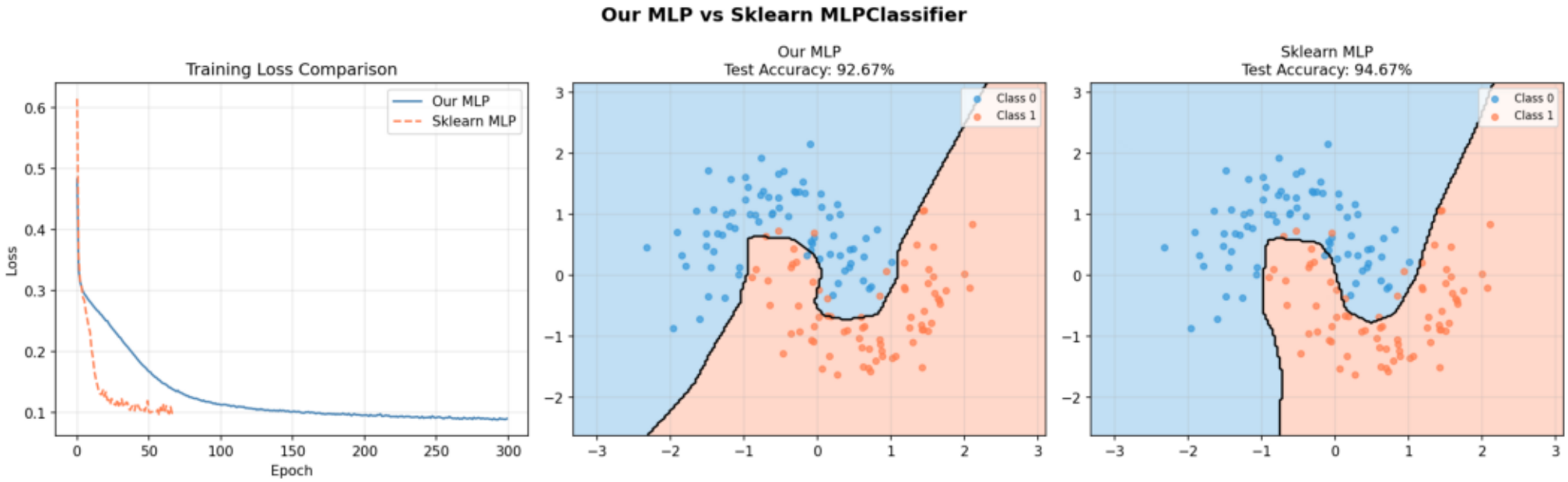
Training Convergence Analysis



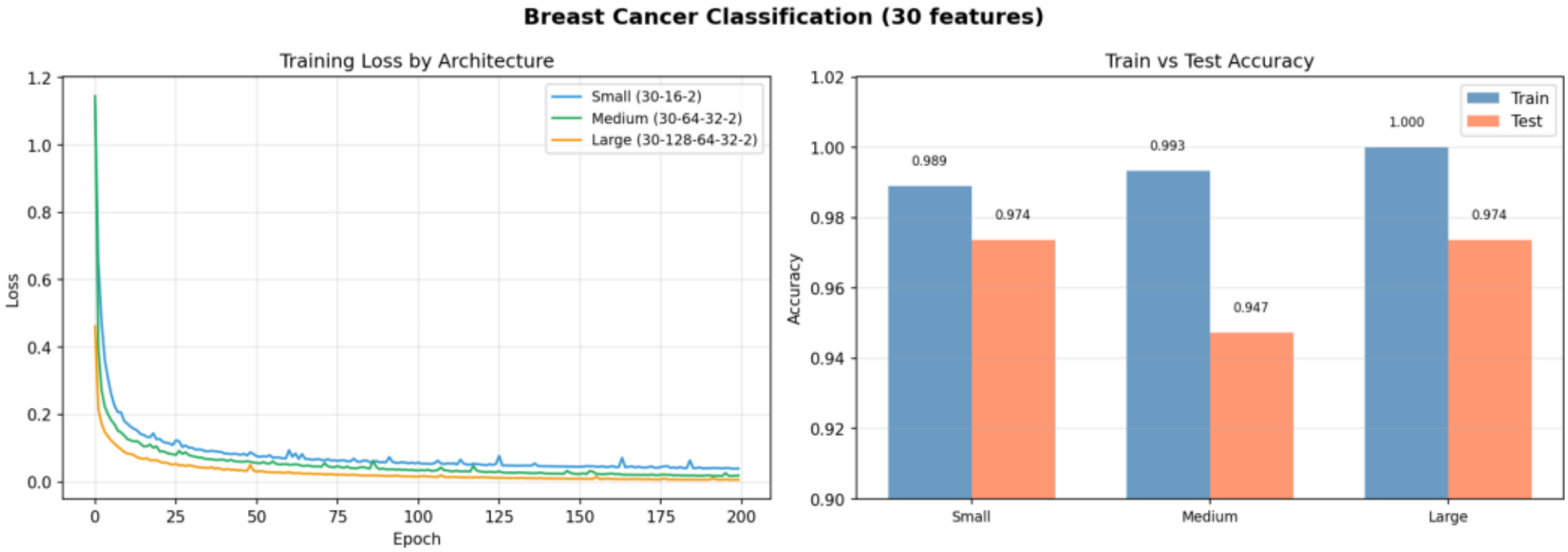
Weight Initialization Comparison



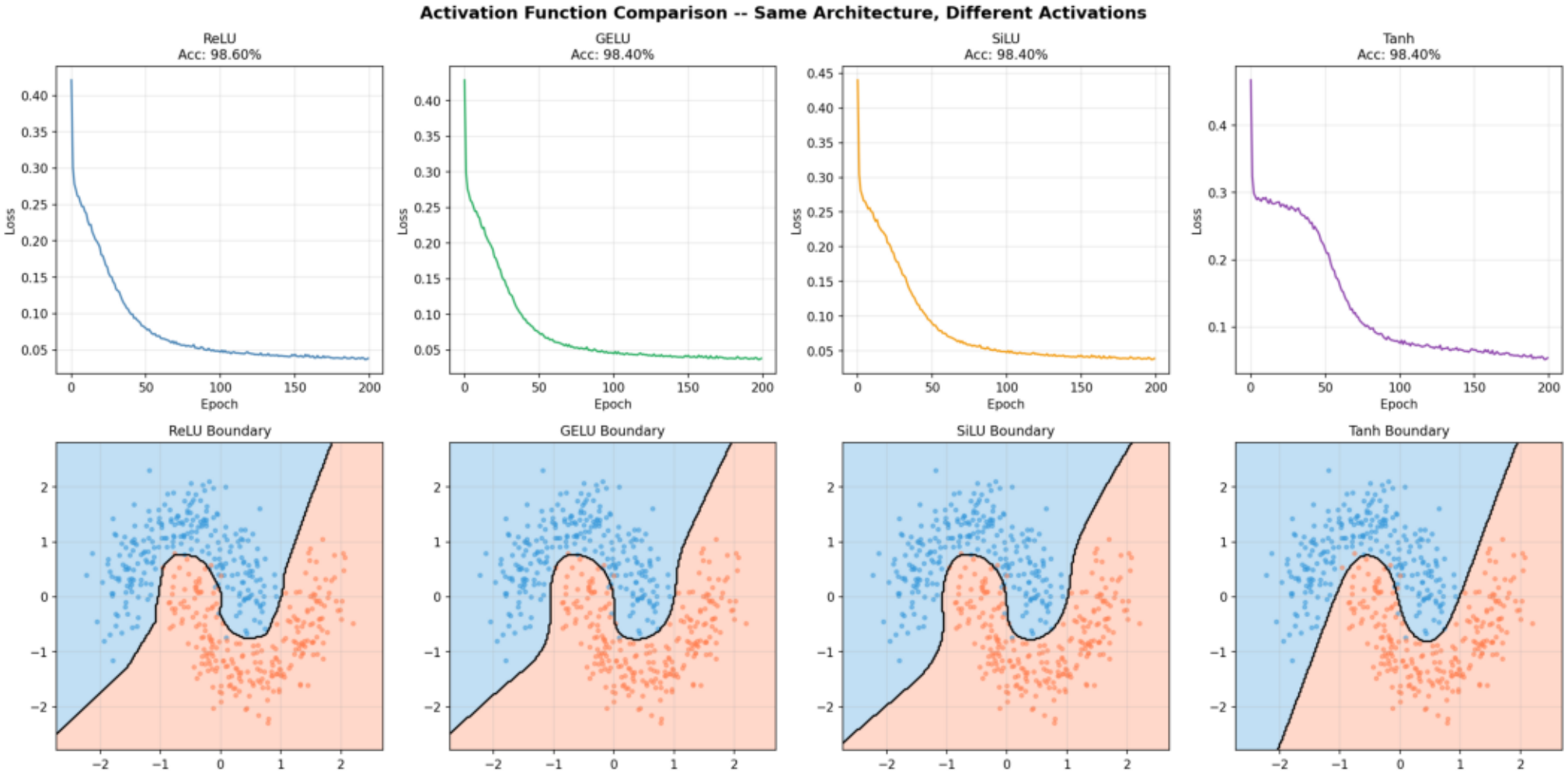
Our MLP vs Sklearn MLPClassifier



Breast Cancer Classification (30 features)



Activation Function Comparison -- Same Architecture, Different Activations



Mini-batch vs Full-batch Training