# Deep Neural Networks

## Activation Functions and Depth Analysis

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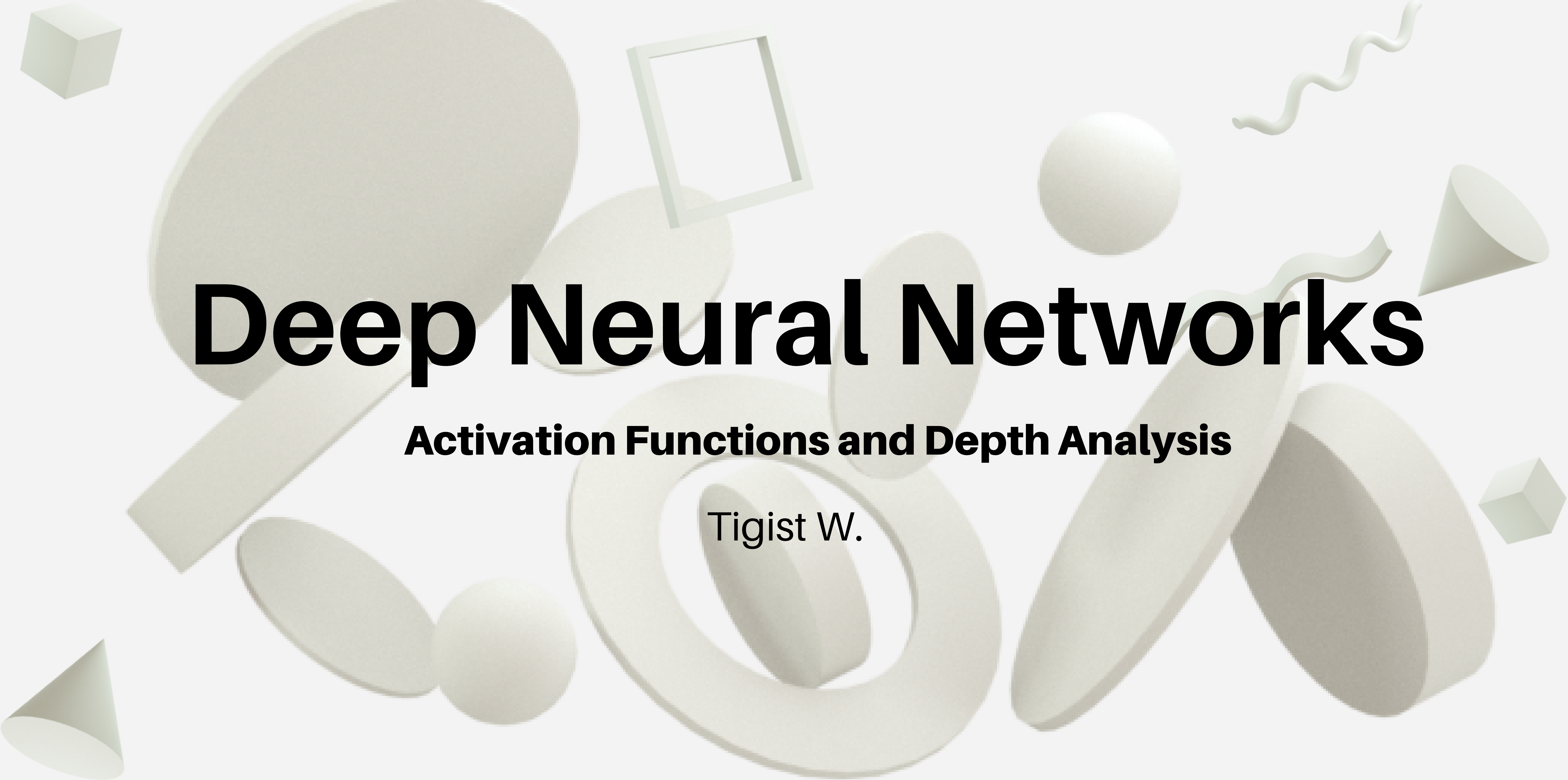
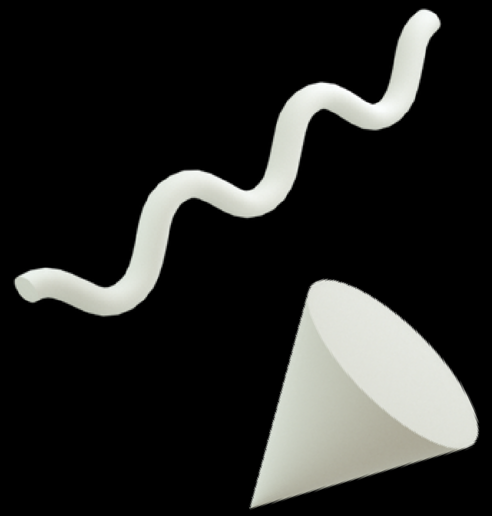


# Introduction



- This mini project explores the impact of different activation functions and the role of network depth in ANNs.
- We compare Sigmoid, Tanh, and ReLU activations.
- Investigate ReLU variants: Leaky ReLU and Parametric ReLU.
- Analyze network performance for different depths.

# Activation Functions Overview

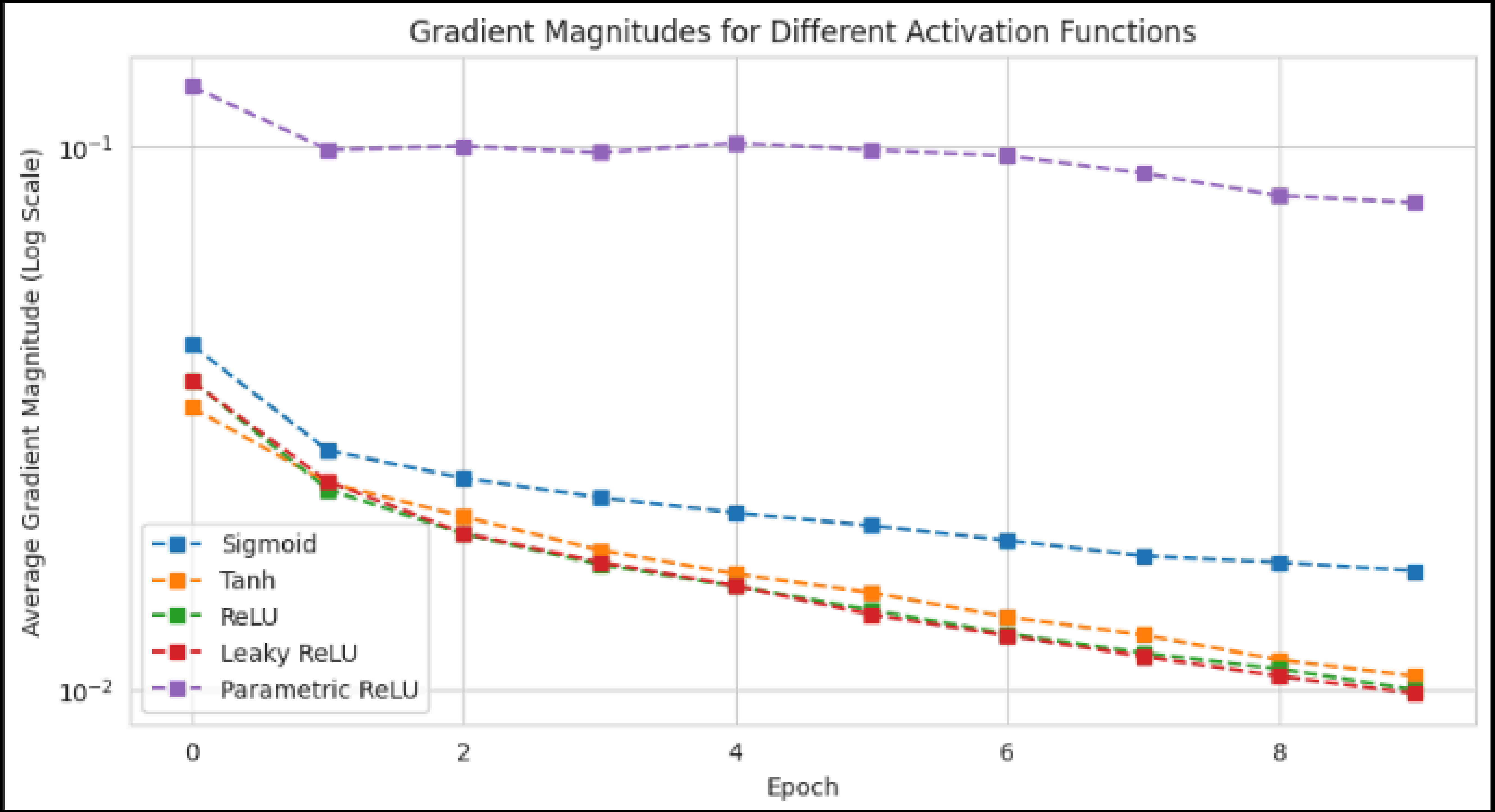
- Sigmoid: Output range (0,1); suffers from vanishing gradients.
- Tanh: Output range (-1,1); still suffers from vanishing gradients.
- ReLU: Allows unbounded positive values; mitigates vanishing gradient issues.
- Leaky ReLU & Parametric ReLU: Fix the dying ReLU problem by allowing small negative slopes.

# Experiment Setup

- **Dataset: MNIST (Handwritten digits classification)**
- **Model: Fully Connected DNN**
- **Evaluation: Loss, gradient magnitude, and accuracy**
- **Tools: PyTorch, Matplotlib for visualizations**

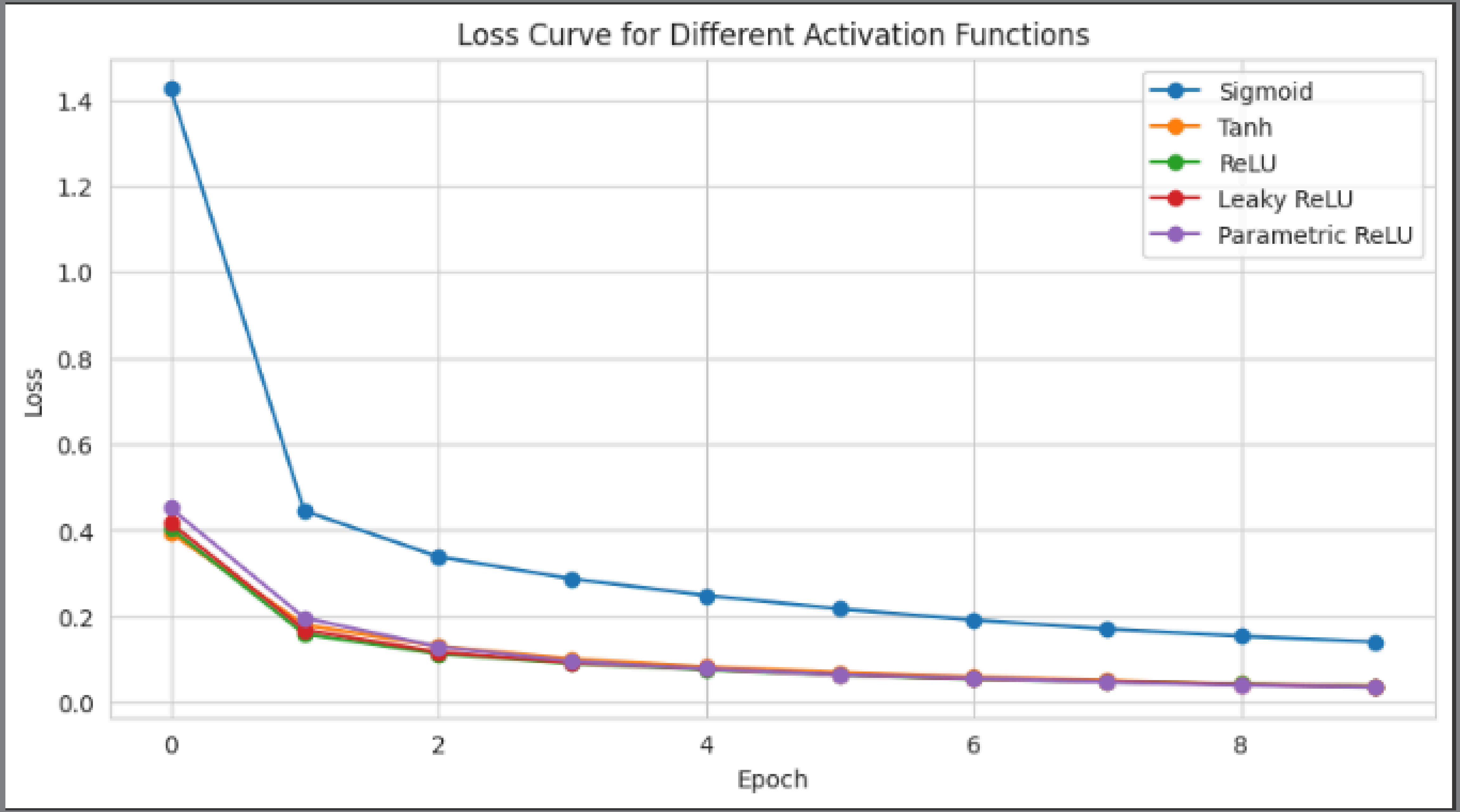
# Activation Function Comparison

## Gradient Magnitude Analysis



# Performance Visualization

## Loss curves: Show that ReLU converges faster than Sigmoid & Tanh.

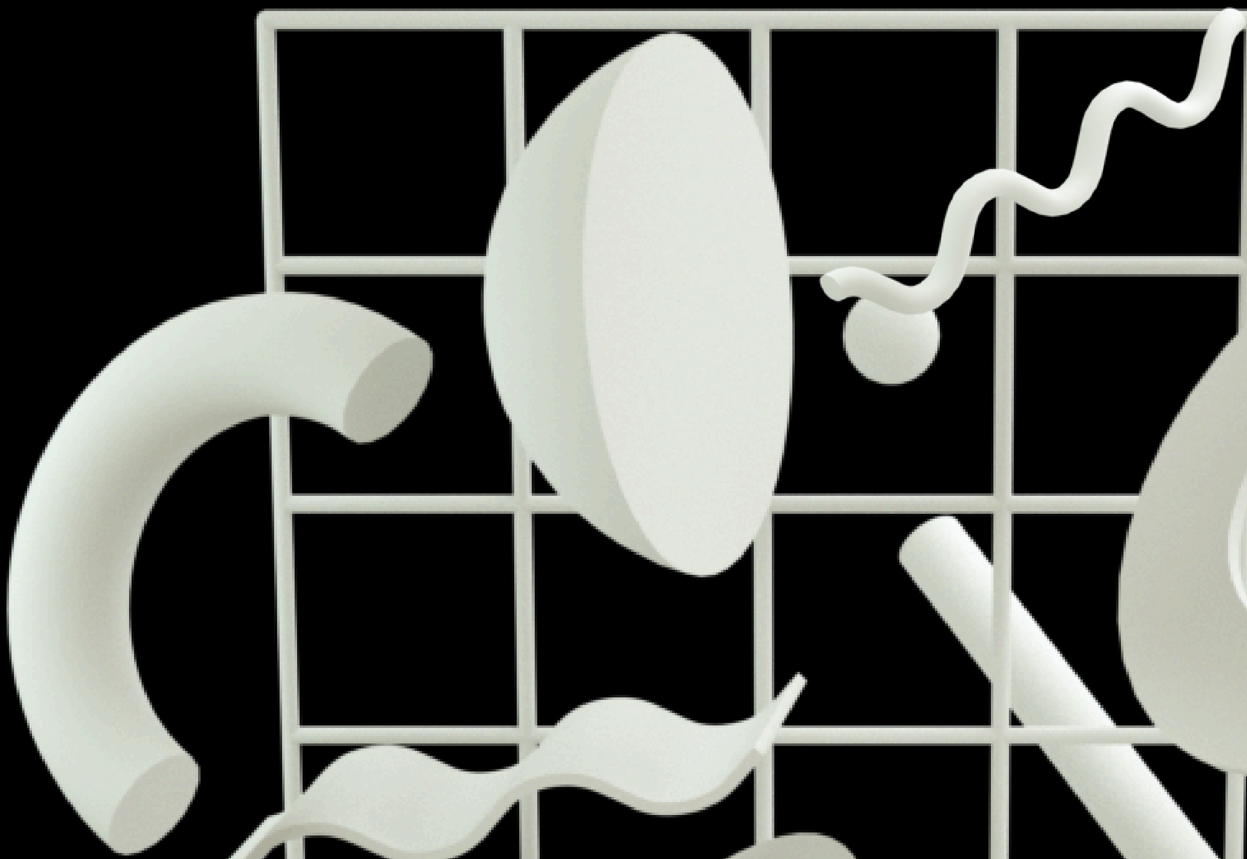


# Depth of ANNs

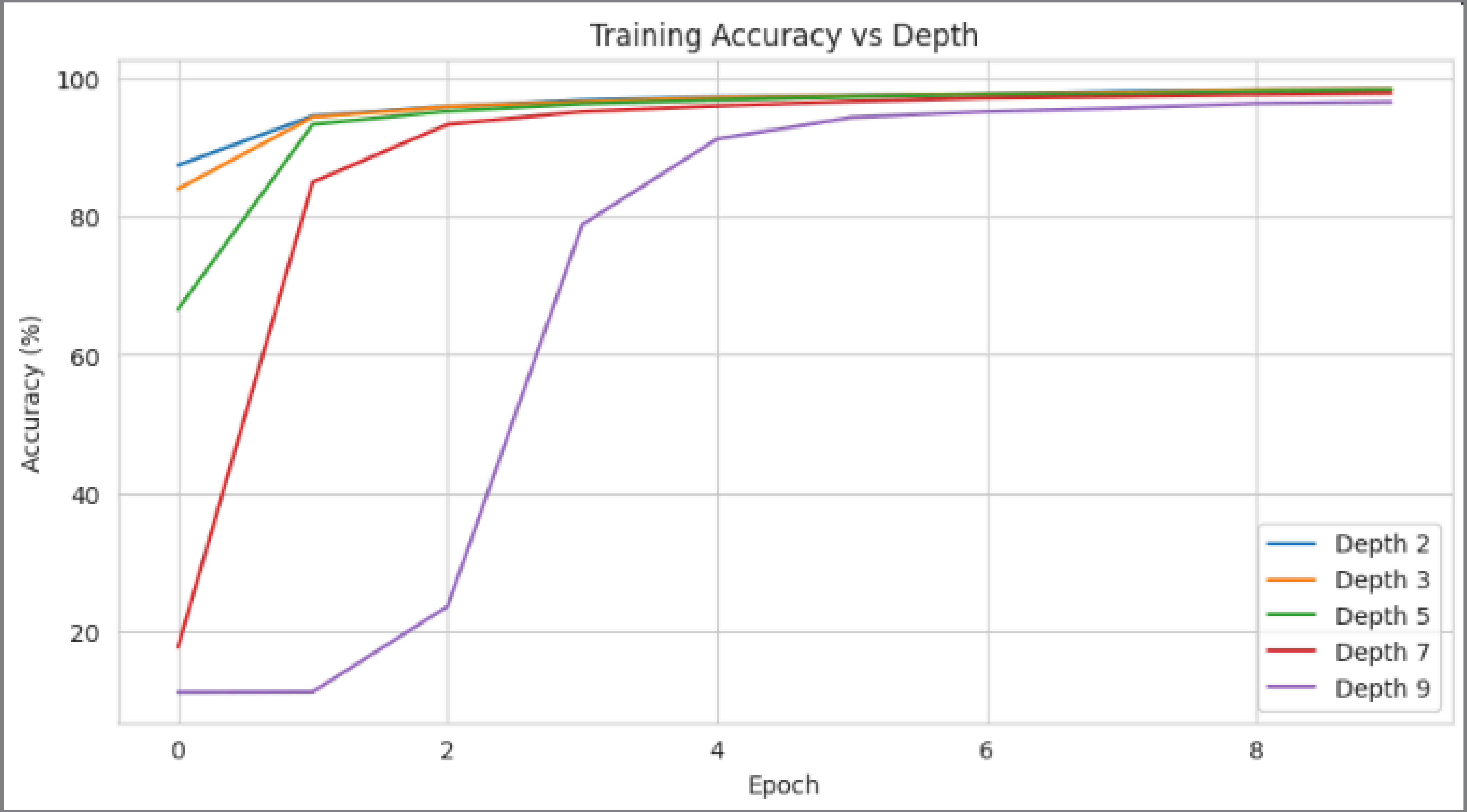
- Testing different network depths:
  - 2-layer shallow network
  - 3-layer moderate network
  - 5-layer deep network
  - 7-layer very deep network
  - 9-layer extra deep network

# Depth vs. Performance

- **Shallow networks: Struggle with feature extraction.**
- **Deep networks (5-7 layers): Achieve optimal accuracy.**
- **Extra deep networks (10+ layers): Show degradation due to vanishing gradients & overfitting.**



# Depth vs. Performance



# Thank You!