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Deep Learning - Course 02456

Project 26: Implementing a Neural Network from Scratch with NumPy or JAX

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Objective

The aim of this project is to design and implement a fully connected feedforward neural network (FFN) from scratch using only NumPy or JAX, without relying on deep learning frameworks such as PyTorch or TensorFlow. This hands-on implementation provides a deeper understanding of the mathematical foundations of neural networks, including forward and backward propagation, loss computation, and gradient-based optimization.

Methodology

The model will be trained and evaluated on small-scale classification datasets such as Fashion-MNIST and CIFAR-10. The implementation will include configurable hyperparameters such as the number of layers, learning rate, batch size, activation functions, weight initialization schemes, and regularization coefficients. Gradient descent optimization (including stochastic gradient descent) will be implemented manually.

Experiment Tracking

All experiments will be logged using Weights & Biases (WandB) to visualize learning curves, parameter distributions, and conduct hyperparameter sweeps for model comparison.

Expected Outcome

The expected outcome is a modular and transparent FFN implementation capable of supervised learning on small datasets, with tracked training metrics and quantitative comparisons of activation functions, optimizers, and initialization strategies. The project will conclude with an analysis of generalization, overfitting, and regularization effects.

References

- Prince, S. J. D. (2023). *Understanding Deep Learning*. MIT Press.
- Goodfellow, I., Bengio, Y., & Courville, A. (2017). *Deep Learning*. MIT Press.
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