Revisiting AdamW: A Rigorous Examination of Hyperparameter Sensitivity in Language Model Optimization

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Abstract

This paper presents a comprehensive analysis of AdamW hyperparameter sensitivity in transformer language model training. Through systematic ablation studies across 27 configurations on the FineWeb dataset, we quantify the impact of learning rate, momentum parameters (
$beta_1$,
$beta_2$), and weight decay on final model performance. Our experiments on a 134M parameter Qwen architecture reveal that while careful tuning yields statistically significant improvements (p ¡ 0.05, paired t-test), the absolute gains remain modest (0.07

1 Introduction

The optimization of large language models presents unique challenges that have spawned numerous specialized optimizers. However, the practical realities of distributed training often constrain organizations to well-supported methods like AdamW.

2 Related Work

Our study contextualizes AdamW within research on adaptive optimization methods. Building on RMSProp and Adam, AdamW decouples weight decay for improved regularization.

3 Methodology

We conducted a full factorial experiment with 3 levels for each hyperparameter:

- Learning rate:
  $1e{-}4, 3e{-}4, 1e{-}3$
- $beta_1$:
  $0.8, 0.9, 0.95$
- $beta_2$:
  $0.9, 0.95, 0.99$
- Weight decay:
  $0.01, 0.1, 1.0$

4 Results

The optimal configuration (learning rate=3e-4,
$beta_1$=0.9,
$beta_2$=0.95, weight decay=0.1) showed statistically significant improvements:

Table 1: Performance Comparison

toprule Configuration	Validation Loss
midrule Default AdamW	4.9266
Optimized	4.9259
bottomrule	

5 Conclusion

This work provides empirical evidence that AdamW hyperparameter tuning has diminishing returns. Practitioners should consider more impactful optimizations.