

Better Call LoRA

Robert Trifan Stefan Popa

University of Bucharest

Abstract

Low-rank adaptation (LoRA) has become a lightweight alternative to full fine-tuning for large language models. In this work, we benchmark vanilla LoRA and four recent LoRA variants: swapped-init LoRA ($A = 0$, $B \sim \mathcal{U}(-0.01, 0.01)$), LoRA-XS ($A \cdot R \cdot B$ factorisation), LoRA+ ($\eta_A \neq \eta_B$ learning rate scaling) and PiSSA-initialised LoRA (SVD(W) warm-start) on the TinyLlama-1.1 B backbone and the GLUE SST-2 sentiment-classification task. All experiments were performed on a single RTX 2070 (8 GB), enforcing strict memory budgets. We report classification accuracy, macro-F1, wall-clock training time and peak GPU memory to highlight the trade-offs each variant offers under resource constrained conditions.

1 Introduction

Large language models (LLMs) have rapidly become the de facto standard for various natural language processing tasks, ranging from search and dialog to code generation and summarization. Their ubiquity is largely attributed to their capacity to learn from vast amounts of data, but this comes at a cost: the computational resources required for training and fine-tuning these models are substantial.

Training or fully fine-tuning these models typically implies billions of parameters, weeks of GPU time and significant energy consumption. Such costs are often out of reach for many practitioners, leading to a growing interest in more efficient alternatives.

Low-rank adaptation (LoRA) [4] tackles this challenge by injecting a pair of low-rank matrices into the weights of a pre-trained model and learning only those additional parameters while freezing

the original model. Despite the simplicity of the approach, LoRA has matched or even surpassed the performance of full fine-tuning on many tasks, while reducing the memory footprint and training time by orders of magnitude.

Building on top of this idea, a growing literature has emerged, proposing improvements that modify the initialization, learning rates schedules or factorisation structure of the low-rank matrices hoping to further enhance the effectiveness of LoRA. While these extensions are promising, their practical impact remains unclear due to inconsistencies in experimental setups.

This survey offers a comprehensive overview of five LoRA variants, including the original LoRA, and benchmarks them on a sentiment classification task using the TinyLlama-1.1B model [7] and the GLUE SST-2 dataset [6]. By standardizing the model size, dataset and evaluation metrics, we aim to provide an apples-to-apples comparison of these methods under realistic resource constraints.

2 Setup

Model Describe TinyLlama-1.1B [7]

Dataset Describe GLUE [6]

Training During training, we cast SST-2 as a single-turn instruction-following language-model task. Formally, for every sentence *sentence* and label *sentiment*, we build the prompt **Classify the sentiment of this sentence:**

`<sentence>\n\nSentiment: <sentiment>\n.`

The tokenized prompt is fed to the model as both `input_ids` and `labels` to ensure the model learns to predict the sentiment label directly. All pretrained model weights stay frozen by setting `requires_grad=False`, while the LoRA parameters are trained with a batch size of 1 and gradient accumulation of 16.

Evaluation At validation time, we feed the same prompt *without* the sentiment token `Classify the sentiment of this sentence: <sentence>\n\n.Sentiment:.` A single forward pass yields the logits for the final position. We manually extract the token for each sentiment and look up its index in the model’s vocabulary. The prediction is the index of the sentiment token with the highest logit.

Metrics Describe the metrics used: accuracy, F1, train time, GPU memory.

3 Low Rank Adaptation

LoRA Describe LoRA [4].

Impact of initialization dynamics on LoRA Describe different LoRA [2]

LoRA-XS Describe LoRA-XS [1].

LoRA+ Describe LoRA+ [3]

PiSSA Describe PiSSA [5]

[4] Edward J. Hu, Yelong Shen, Phillip Wallis, Zeyuan Allen-Zhu, Yuanzhi Li, Shean Wang, Lu Wang, and Weizhu Chen. Lora: Low-rank adaptation of large language models, 2021.

[5] Fanxu Meng, Zhaohui Wang, and Muhan Zhang. Pissa: Principal singular values and singular vectors adaptation of large language models, 2025.

[6] Alex Wang, Amanpreet Singh, Julian Michael, Felix Hill, Omer Levy, and Samuel R. Bowman. Glue: A multi-task benchmark and analysis platform for natural language understanding, 2019.

[7] Peiyuan Zhang, Guangtao Zeng, Tianduo Wang, and Wei Lu. Tinyllama: An open-source small language model, 2024.

4 Experiments

For each method, describe the hyperparameters explored with a table.

Gather the best results into a final table, comparing the methods.

5 Conclusion

Explain that, because of limited compute resources, we couldn’t see meaningful results.

References

- [1] Klaudia Bałazy, Mohammadreza Banaei, Karl Aberer, and Jacek Tabor. Lora-xs: Low-rank adaptation with extremely small number of parameters, 2024.
- [2] Soufiane Hayou, Nikhil Ghosh, and Bin Yu. The impact of initialization on lora finetuning dynamics, 2024.
- [3] Soufiane Hayou, Nikhil Ghosh, and Bin Yu. Lora+: Efficient low rank adaptation of large models, 2024.