An Empirical Study on Private Inference for Large Language Models

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Abstract

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1 Introduction

2 Background

2.1 LLM Inference

Transformer, Q, K, V, Attention, Multi-head, LayerNorm, FFN

Prefill & Decode

2.2 LLM Serving

Chucked Prefill, PD Disaggregation

Difference with general server-client model

Optimization Goal: Latency, Throughput, Energy

2.3 Private Cloud Compute

2.3.1 Taxonomy

Disclosed privacy threats

3 Optimization

Academic and industrial systems

3.1 Parallel Processing

Speculative inference. Pipeline Parallelism. Sequence Parallelism. Tensor Parallelism.

3.2 Batch Processing

Iteration-level batch, chunked prefill, prepack prefill.

Submitted to 38th Conference on Neural Information Processing Systems (NeurIPS 2024). Do not distribute.

3.3 Memory Management

kv cache.

paging, disk offloading, prefix caching, MQA, GQA.

3.4 Transmission

Duplication. Pulling. request migration. disaggregated architecture.

3.5 Scheduler

priority-based, stateful scheduler. local schduler, instance flip.

Global profiling. request-level prediction

4 Threats

4.1 Threats from the System Domain

4.1.1 Threats from the LLM System

5 Discussion

Mitigation

Design Principle

References

References follow the acknowledgments in the camera-ready paper. Use unnumbered first-level heading for the references. Any choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font size to `small` (9 point) when listing the references. Note that the Reference section does not count towards the page limit.

[1] Alexander, J.A. & Mozer, M.C. (1995) Template-based algorithms for connectionist rule extraction. In G. Tesauro, D.S. Touretzky and T.K. Leen (eds.), *Advances in Neural Information Processing Systems 7*, pp. 609–616. Cambridge, MA: MIT Press.

[2] Bower, J.M. & Beeman, D. (1995) *The Book of GENESIS: Exploring Realistic Neural Models with the GEneral NEural SImulation System.* New York: TELOS/Springer–Verlag.

[3] Hasselmo, M.E., Schnell, E. & Barkai, E. (1995) Dynamics of learning and recall at excitatory recurrent synapses and cholinergic modulation in rat hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.

A Appendix / supplemental material

Optionally include supplemental material (complete proofs, additional experiments and plots) in appendix. All such materials **SHOULD be included in the main submission.**

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