

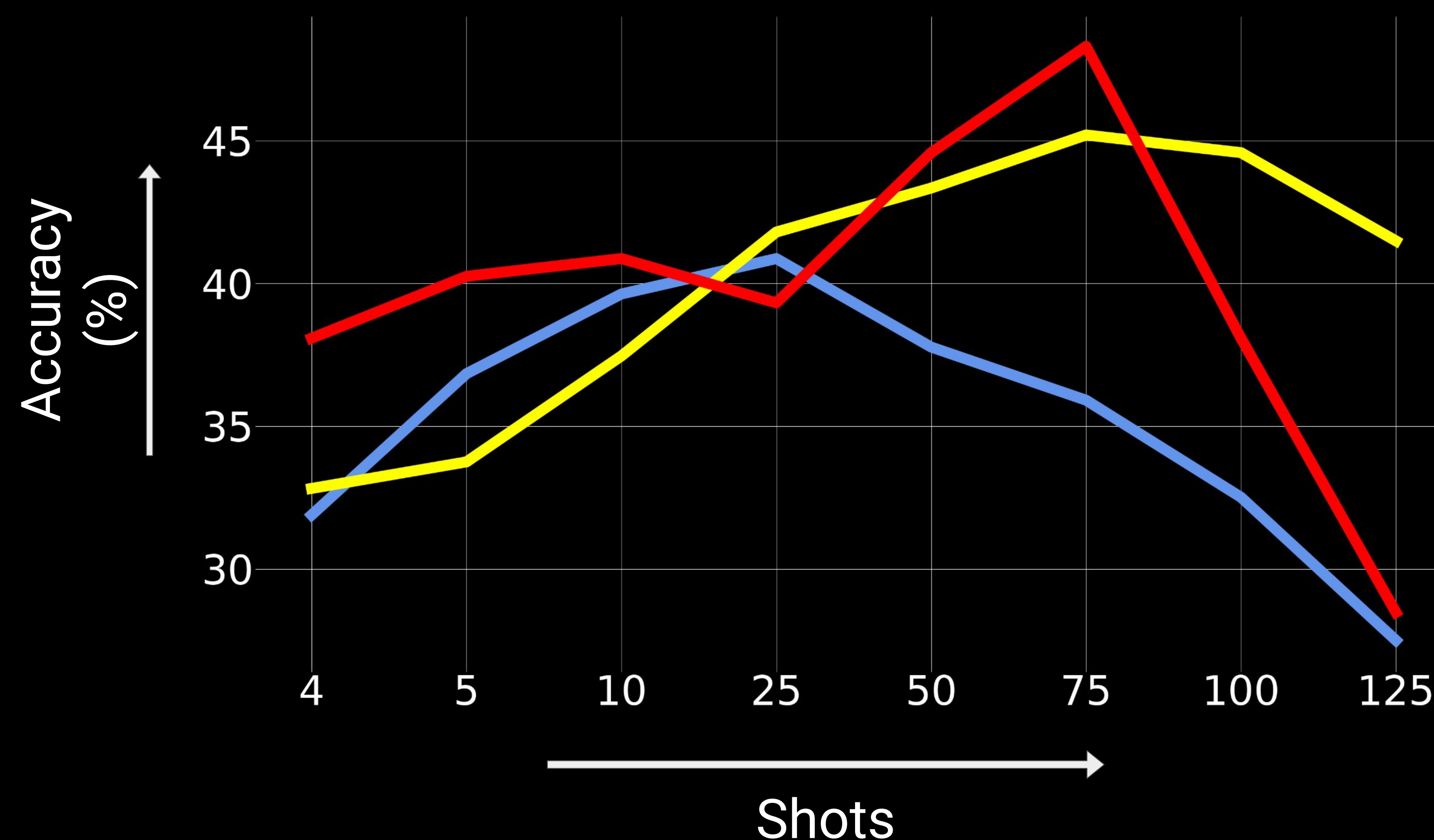
Unsupervised Many-Shot ICL for MATH

Just Asking Questions Without Explanations or Answers Boosts LLM Accuracy
at least that's what Google Says; And we verify...

ICL Information

Questions &
Answers
Questions
Only

Synthetic Q&A



MATH500 [6] * Performance with Llama 3.1-8B-Instruct [3]

Results

- With more examples unsupervised ICL outperforms supervised ICL
- With more examples reinforced ICL outperforms supervised ICL
- Claim from [1] on Gemini transfers to Llama 3..1 8B Instruct [3]

Introduction

- Recent research explores benefit of long context in LLMs for
 - Solving math problems [1]
 - In Context Learning [4]
 - Retrieval Augmented Generation [5]
- Google DeepMind [1] proposes ICL improvements from long context for MATH500 [6]
- MATH500 [6] is a part of MATH [2] a dataset of 12,500 high school math problems
- Unsupervised and Reinforced ICL observed to be better than Supervised ICL as a trend [1]

Methodology

- Supervised ICL: ICL examples with labels
- Unsupervised ICL: ICL examples without labels
- Reinforced ICL: Synthetic ICL examples with labels
- Evaluate Unsupervised, Supervised and Reinforced ICL performance
- Experiment with 5, 10, 25, 50, 75, 100, 125 shots
- Experiment with small and open source model: Llama 3.1 8B instruct [3]
- Success is measured as % of problems solved correctly

References

- [1] Rishabh Agarwal, Avi Singh, Lei M. Zhang, Bernd Bohnet, Luis Rosias, Stephanie Chan, Biao Zhang, Ankesh Anand, Zaheer Abbas, Azade Nova, John D. Co-Reyes, Eric Chu, Feryal Behbahani, Aleksandra Faust, and Hugo Larochelle. Many-shot in-context learning, 2024. URL <https://arxiv.org/abs/2404.11018>.
- [2] Karl Cobbe, Vineet Kosaraju, Mohammad Bavarian, Mark Chen, Heewoo Jun, Lukasz Kaiser, Matthias Plappert, Jerry Tworek, Jacob Hilton, Reiichiro Nakano, Christopher Hesse, and John Schulman. Training verifiers to solve math word problems, 2021b. URL <https://arxiv.org/abs/2110.14168>.
- [3] <https://huggingface.co/meta-llama/Llama-3.1-8B-Instruct>
- [4] Amanda Bertsch, Maor Ivgi, Uri Alon, Jonathan Berant, Matthew R. Gormley, and Graham Neubig. In context learning with long-context models: An in depth exploration, 2024. URL <https://arxiv.org/abs/2405.00200>
- [5] Bowen Jin, Jinsung Yoon, Jiawei Han, and Sercan O. Arik. Long-context llms meet rag: Overcoming challenges for long inputs in rag, 2024. URL <https://arxiv.org/abs/2410.05983>.
- [6] <https://huggingface.co/datasets/gq8933/MATH500>
<https://www.cmu.edu/brand/brand-guidelines/visual-identity/logos.html>



Rajeev Veeraraghavan Anish Kiran Kulkarni Ajay Mittur
rveerara@andrew.cmu.edu anishkik@andrew.cmu.edu amittur@andrew.cmu.edu

Unsupervised Many-Shot ICL for MATH

Just Asking Questions Without Explanations or Answers Boosts LLM Accuracy
at least that's what Google Says; And we verify...

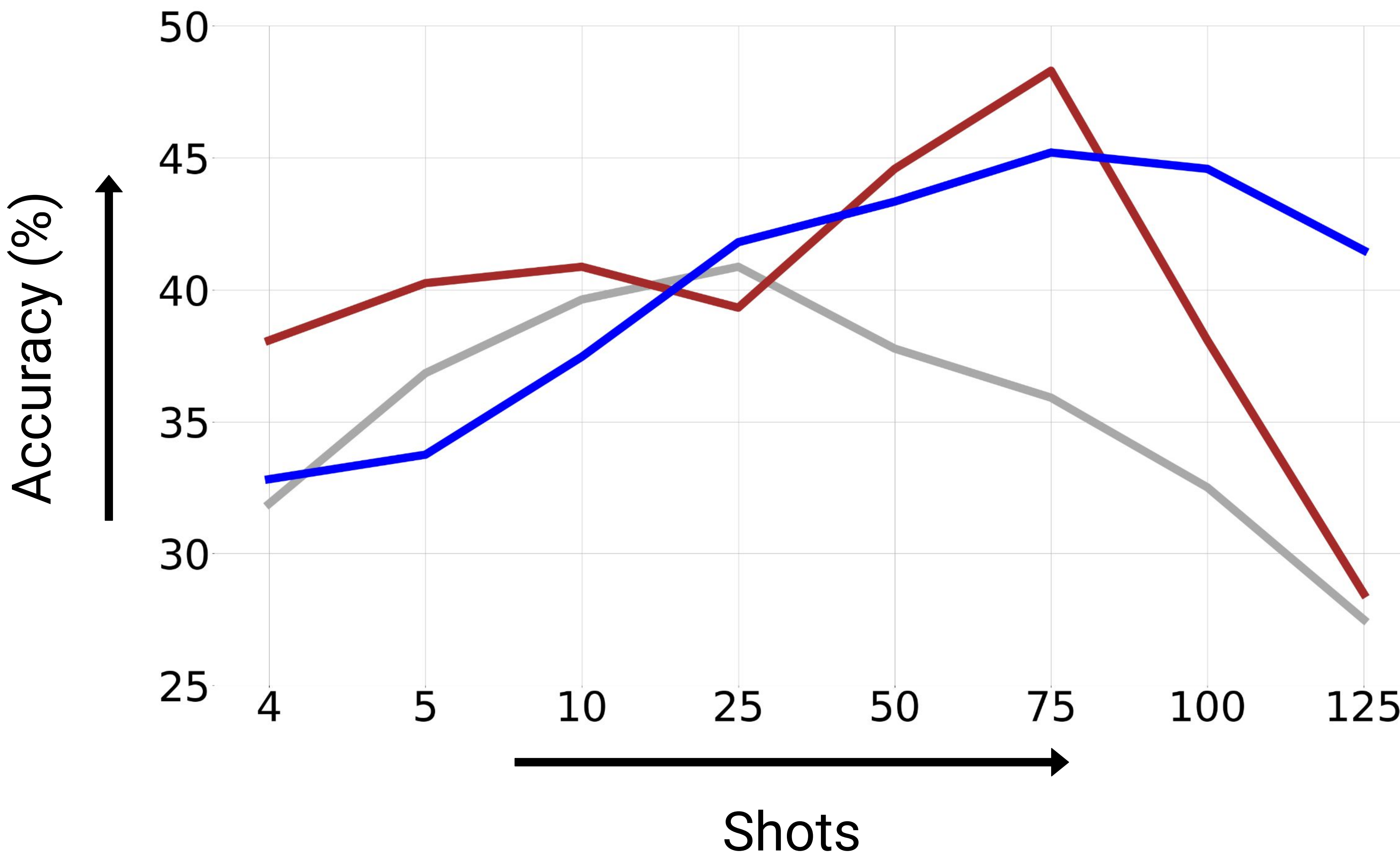
MATH500 ^[6] * Performance with Llama 3.1-8B-Instruct ^[3]

What's in the ICL Prompt:

Questions & Answers

Questions Only

Synthetic Q&A



Results

- With more examples (many shots) for ICL:
 - Unsupervised > Supervised
 - Reinforced > Supervised
- Claims from Google DeepMind ^[1] on Gemini transfer to Llama3.1-8B-Instruct ^[3]

Introduction

- Recent research explores benefits of long context in LLMs for
 - Solving math problems ^[1]
 - In Context Learning ^[4]
 - Retrieval Augmented Generation ^[5]
- Google DeepMind ^[1] proposes ICL improvements from long context for MATH500 ^[6]
- MATH500 ^[6] is a part of MATH ^[2] a dataset of 12,500 high school math problems
- Unsupervised and Reinforced ICL observed to be better than Supervised ICL as a trend ^[1]

Methodology

- Supervised ICL: ICL examples with labels (questions and answers)
- Unsupervised ICL: ICL examples without labels (questions only)
- Reinforced ICL: Synthetic ICL examples (model generated reasoning)
- Evaluate Unsupervised, Supervised and Reinforced ICL performance
- Experiment with 5, 10, 25, 50, 75, 100, 125 shots
- Experiment with small and open source model: Llama3.-8B-Instruct ^[3]
- Success is measured as % of problems solved correctly

References

[1] Rishabh Agarwal, Avi Singh, Lei M. Zhang, Bernd Bohnet, Luis Rosias, Stephanie Chan, Biao Zhang, Ankesh Anand, Zaheer Abbas, Azade Nova, John D. Co-Reyes, Eric Chu, Feryal Behbahani, Aleksandra Faust, and Hugo Larochelle. Many-shot in-context learning, 2024. URL <https://arxiv.org/abs/2404.11018>.
 [2] Karl Cobbe, Vineet Kosaraju, Mohammad Bavarian, Mark Chen, Heewoo Jun, Lukasz Kaiser, Matthias Plappert, Jerry Tworek, Jacob Hilton, Reiichiro Nakano, Christopher Hesse, and John Schulman. Training verifiers to solve math word problems, 2021b. URL <https://arxiv.org/abs/2110.14168>.
 [3] <https://huggingface.co/meta-llama/Llama-3.1-8B-Instruct>
 [4] Amanda Bertsch, Maor Ivgi, Uri Alon, Jonathan Berant, Matthew R. Gormley, and Graham Neubig. In context learning with long-context models: An in depth exploration, 2024. URL <https://arxiv.org/abs/2405.00200>.
 [5] Bowen Jin, Jinsung Yoon, Jiawei Han, and Serkan O. Arik. Long-context llms meet rag: Overcoming challenges for long inputs in rag, 2024. URL <https://arxiv.org/abs/2410.05983>.
 [6] <https://huggingface.co/datasets/gq8933/MATH500>
 [7] <https://www.cmu.edu/brand/brand-guidelines/visual-identity/logos.html>
 [8] <https://www.ml.cmu.edu/>
 *Numeric Subset