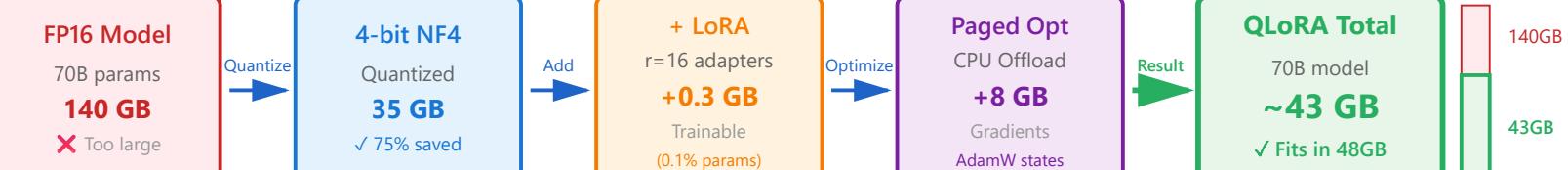


QLoRA: Quantized Low-Rank Adaptation

4-bit Quantization + LoRA

Train 70B models on single 48GB GPU



75%

Memory Reduction

<1%

Performance Loss

24GB

Min GPU Memory

Key Benefits

- Enables large model fine-tuning
- Reduces training costs
- Maintains model accuracy
- Faster convergence



Implementation Details

- NF4 (Normal Float 4-bit)
- Paged optimizers
- Double quantization
- BitsAndBytes library