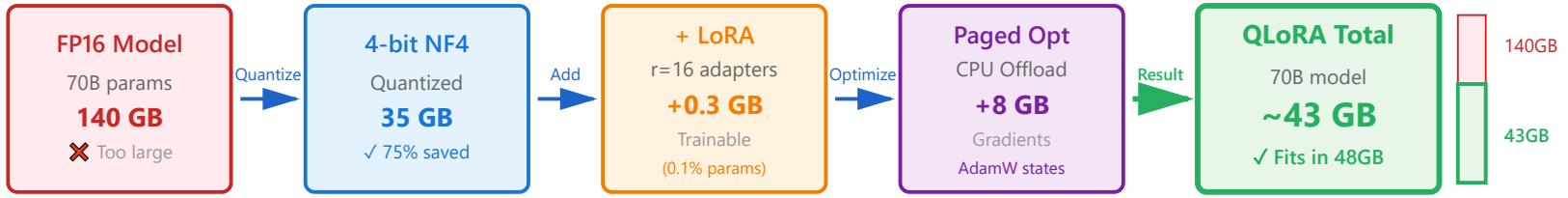
# QLoRA: Quantized Low-Rank Adaptation

**4-bit Quantization + LoRA**
Train 70B models on single 48GB GPU




| 75% | <1% | 24GB |
|---|---|---|
| Memory Reduction | Performance Loss | 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