ADL2025-HW2 Assignment Report

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Q1: LLM Tuning

Training Data Usage

- **Dataset:** Chinese instruction tuning dataset provided by TA
- **Training samples:** 10000 examples
- **Data format:** Instruction-response pairs in JSON format
- **Preprocessing:** Used custom prompt for classical Chinese tasks

Model Tuning Method

- **Technique:** QLoRA (Quantized Low-Rank Adaptation)
- **Base Model:** Qwen3-4B (4 billion parameters)
- **Quantization:** 4-bit NormalFloat with double quantization
- **LoRA Configuration:**
    - Rank (r): 16
    - Alpha: 32
    - Dropout: 0.1
    - Target modules: q_proj, k_proj, v_proj, o_proj

Hyperparameters

Parameter	Value
Learning Rate	2e-4
Batch Size	1
Gradient Accumulation Steps	8
Max Sequence Length	256
Number of Epochs	3
Optimizer	AdamW
Weight Decay	0.01
Warmup Steps	100
LR Scheduler	Cosine

Final Performance on the Public Testing Set

- **Test Perplexity:** 6.506
- **GPU Used:** RTX 2080 (8GB VRAM)
- **Training Time:** 7 hours
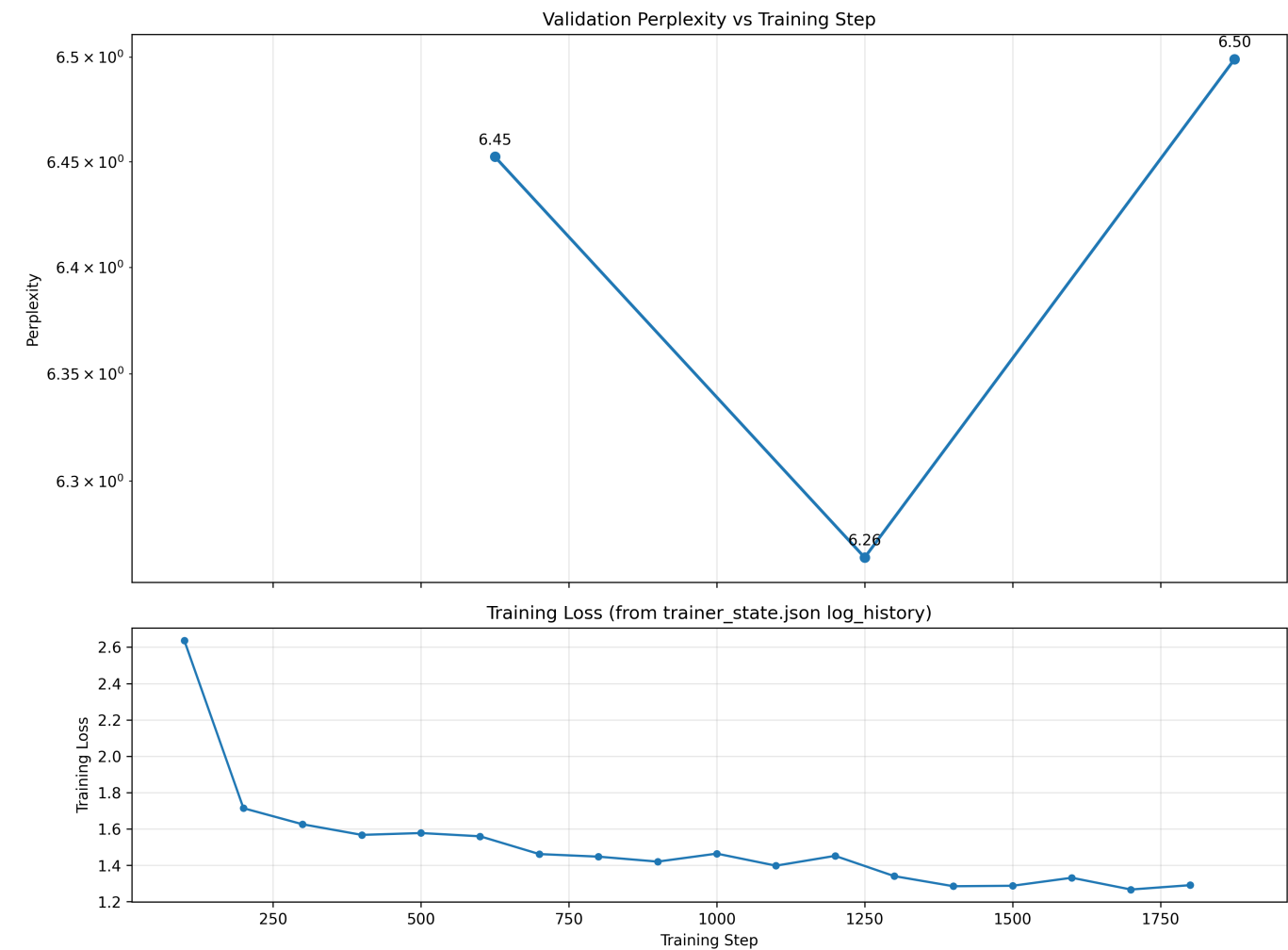
Learning Curve

Figure 1: Training loss and validation perplexity over 3 epochs

Observations:

- Training loss reduced after 3 epochs
- Perplexity didn't keep reducing (might because of overfitting)

Q2: LLM Inference Strategies

Zero-Shot Setting

Model: Original Qwen3-4B (no fine-tuning)
Prompt Design:

```
你是古文的專家，負責轉換古代文言文與現代白話文。接下來是你跟用戶的對話，你要對用戶的問題提
供簡潔、有用、精確的轉換。USER:{instruction} ASSISTANT:
```

Few-Shot Setting

Model: Original Qwen3-4B (no fine-tuning)
In-context Examples: 5 examples
Selection Method: Select multiple different types of instructions to cover as much prompt formats as possible. Ex. "翻譯成文言文", "幫我把這句話翻譯成文言文", "將下麵句子翻譯成文言文", "把這句話翻譯成現代文" are 4 different format types.

Prompt Design:

> 你是古文的專家，負責轉換古代文言文與現代白話文。接下來是你跟用戶的對話，你要對用戶的問題提供簡潔、有用、精確的轉換。以下為幾個正確翻譯的範例 \n [USER: {instruction} ASSISTANT: {output}\n] x N 接下來是你要翻譯的句子，根據前面的正確範例，進行翻譯\n USER: {instruction} ASSISTANT:

Results Comparison

Method	Test Perplexity
Zero-Shot (Original)	35.182
Few-Shot (Original)	23.474
QLoRA Fine-tuned	6.506

Key Differences:

- **Zero-Shot:**
  - Pros: Fastest, no training or setup needed; often good enough for generic instructions.
  - Cons: Struggles with specialized domains, consistent formatting, or domain-specific tone; risk of factual gaps or inconsistent outputs.
  - Best use: Quick tests, general-purpose tasks, or non-critical applications.
- **Few-Shot:**
  - Pros: Improves task/format specific performance (e.g., sequence transformation, structured outputs, code templates) without retraining.
  - Cons: Consumes context window; inconvenient for production since examples must be included every time; limited gains for highly specialized domains.
  - Best use: Prototyping, enforcing output formats, quick adaptation.
- **LoRA:**
  - Pros: Stabilizes and persists domain-specific behavior - keeps custom tone, terminology, and task-specific improvements without needing few-shot prompts every time. Flexible - LoRA adapters can be applied or removed easily, supporting A/B testing and version control.
  - Cons: Risk of overfitting or interfering with base model behaviors if rank or learning rate is set too high.
  - Best use: Production tasks with repetitive specialized requirements (e.g., corporate customer support, legal summarization, domain-specific structured outputs).

Q3: Bonus - Llama3-Taiwan (8B)

Experimental Settings

- **Base Model:** Llama3-Taiwan-8B
- **Training Data:** Same classical Chinese dataset provided by TA
- **QLoRA Configuration:**
    - Rank (r): 8
    - Alpha: 32
    - Learning Rate: 2e-4
    - Epochs: 2

Results Comparison

Model	Parameters	Test Perplexity	Training Time
Qwen3-4B	4B	6.506	7hr
Llama3-Taiwan-8B	8B	4.853	13hr

Analysis

Advantages of Llama3-Taiwan:

- Taiwan-specific optimization: Llama3-Taiwan is based on Llama-3 but fine-tuned with Traditional Mandarin and Taiwanese corpora, so it tends to perform better in local wording, tone, and cultural appropriateness.
- Larger model options available (for higher quality generation): There are 70B versions of Llama3-Taiwan (as well as smaller ones like 8B). Larger models naturally have clear advantages in reasoning, multi-turn conversations, and text quality.
- Instruction / dialogue fine-tuning: Llama-3 models include instruction-tuned weights, and Llama3-Taiwan is also an instruct version, which makes it friendlier for following user instructions and maintaining context.

Trade-offs:

- Compared with Llama3-Taiwan-8B, Qwen3-4B is a compact 4B model with strong performance relative to its size. It's designed for efficient inference and is attractive for resource-constrained deployments.
- More memory and training resource is needed to train Llama3-Taiwan-8B due to larger parameter size compared with Qwen3-4B.

Summary

This assignment successfully implemented QLoRA fine-tuning for classical Chinese instruction following tasks. The key achievements include:

1. **Efficient Training:** Successfully fine-tuned large language models on consumer GPU
2. **Strong Performance:** Achieved perplexity of 6.506 on classical Chinese tasks
3. **Comprehensive Evaluation:** Compared zero-shot, few-shot, and fine-tuning approaches

4. **Bonus Implementation:** Evaluated Llama3-Taiwan model

The results demonstrate the effectiveness of QLoRA for domain-specific language model adaptation while maintaining computational efficiency.

Reference

1. ChatGPT
2. Github Copilot
3. Llama-3-Taiwan-8B-Instruct
4. Qwen3-4B