

Project

Please submit the report (in pdf format) on Blackboard system before 23:59 Dec. 22.

Report can be written either in English or Chinese. Name your report as

`studentID_Name.pdf`. If you use LLMs etc., list the name of LLM and all the prompts you use. Note that the LLM may have hallucination problem and you are responsible for the correctness of the answers.

Background

Suppose you are starting a startup to develop innovative LLM-based agents for educational purpose. Your product aims to provide personalized education copilot for college students. The product can offer courses at different difficulty levels based on the feedbacks from the students in a conversational manner. The key challenges are as follows:

- (1) Generate quizzes and questions with varying difficulty levels given a certain topic in a course.
- (2) Evaluation the learning outcome of students based on generated quizzes and conversations.
- (3) Generate responses with the corresponding difficulty level for the provided questions.
- (4) Provide feedbacks for further improvement.

You can read and try to address more challenges with the following references:

- [Towards Responsible Development of Generative AI for Education: An Evaluation-Driven Approach](#)
- [Large Language Models for Education: A Survey and Outlook](#)
- [LLM Agents for Education: Advances and Applications](#)
- [Simulating Classroom Education with LLM-Empowered Agents](#)

Q1. Data Synthesis

The first step to finetune the LLM to adapt to the education domain is to synthesize instruction data. Read the references below and complete the following sub-tasks.

- (1) [2 points] Illustrate and explain two methods (for each) to generate/synthesize SFT data as well as preference data with high-quality.
- (2) [2 points] Write code to generate 2000 SFT data samples and 2000 preference data samples that can be used to finetune an education LLM. It is recommended that you explore your own methods or combine multiple approaches to create a more effective framework.
- (3) [2 points] Illustrate and explain two methods to filter data samples.
- (4) [2 points] Write code to filter to keep 1k data samples and 1k preference samples.

References (1)

SFT data synthesis

- Stanford Alpaca: An Instruction-following LLaMA Model
- WizardLM: Empowering large pre-trained language models to follow complex instructions
- Large Language Models for Data Annotation and Synthesis: A Survey
- Live LLM-Synthetic-Data Papers

References (2)

Preference data synthesis

- FSPO: Few-Shot Preference Optimization of Synthetic Preference Data in LLMs Elicits Effective Personalization to Real Users
- ALMA: Alignment with Minimal Annotation
- AIR: A Systematic Analysis of Annotations, Instructions, and Response Pairs in Preference Dataset
- Filtered Direct Preference Optimization

References (3)

Data selection

- A Survey on Data Selection for Language Models
- What Makes Good Data for Alignment? A Comprehensive Study of Automatic Data Selection in Instruction Tuning
- Take the Essence and Discard the Dross: A Rethinking on Data Selection for Fine-Tuning Large Language Models

Q2. LLM Post-Training

With the synthesized training data in the education domain, you can finetune from a general-domain LLM with supervised-finetuning (SFT) and preference tuning, and get your customized educational LLM. We use [Qwen-2.5-0.5B base model](#) as the start.

- (1) [2 points] write code to SFT and then DPO with above filtered data samples in Q1.
- (2) [2 points] write code evaluate the performance of finetuned LLMs after SFT and DPO. You can label 5 test data samples for the education copilot application by yourself and evaluate with the LLM-as-a-Judge approach. You can use [deepseek-v3 api](#) as the LLM judge.

Note that you can look [here](#) for more GPU resources.

References

- SFT Trainer (Hugging Face)
- DPO Trainer (Hugging Face)
- Alignment Handbook: Robust recipes to continue pretraining and to align language models with human and AI preferences.
- LLaMA-Factory: Unified Efficient Fine-Tuning of 100+ LLMs & VLMs
- OpenRLHF: An Easy-to-use, Scalable and High-performance RLHF Framework
- Open-Instruct framework

Q3. Educational Copilot

Design an LLM-based multi-agent system for the education application mentioned above.

- (1) [4 points] Illustrate and explain your strategy and pipeline to build the educational multi-agent framework. Write code and prompt to implement your strategy.
- (2) [2 points] Case study. List one cases that your agent achieves good performance that is out of your expectation, as well as one cases your agent fail unexpectedly. In all cases, list your task descriptions, agent responses and the reference/ground-truth responses.

References

- Awesome AI agent
- AutoGen: Enabling Next-Gen LLM Applications via Multi-Agent Conversation
- AutoGPT: Build, Deploy, and Run AI Agents
- LangGraph: Build resilient language agents as graphs.
- LLM Agents for Education: Advances and Applications
- EduPlanner: LLM-Based Multi-Agent Systems for Customized and Intelligent Instructional Design
- Simulating Classroom Education with LLM-Empowered Agents

Q4. Startup Business Plan

- (1) [2 points] Suppose you plan to build a profitable startup focusing on educational LLM applications. Brainstorm the idea for a startup and write a business plan for your curated education agent product (see references [here](#) and [here](#)) with the help of LLM. Compare your product with two main competitors in the market.
- (2) [2 points] With the help of LLMs, write a [roadshow presentation ppt](#) to secure funding.

Note that you can refer to the ideas on [Product Hunt](#) as well as the suggestions on [how to startup a company](#).

Presentation

[3 points] Every student prepares and submits a ten-minutes PPT about these tasks. Due to time limit, twenty students who are randomly selected will share their work and thoughts in the class of Week 16.