Multi-Agent + Chroma RAG 英文學 習助教系統:研究實作

作者: 張祐豪 網學所 碩一 113524013

Github: https://github.com/a88019401/TW_English_assistant-_Multi-Agent_RAG.git

研究目的

本研究旨在探索 Multi-Agent 協同工作結合 Chroma Vector Database 檢索增強 (RAG, Retrieval-Augmented Generation) 於英語學習輔助 系統之應用,設計一套能夠模擬英語助教 (English Assistant Teacher) 與英語題目設計老師 (English Test Designer) 協同工作 之智慧學習平台。

本系統與傳統僅依賴單一大型語言模型(如 ChatGPT)之對話型學習輔助工具相比,展現了明顯優勢。

傳統 ChatGPT 常因未能考慮學科領綱與學年進度,容易產出偏頗、超出學生認知負荷或脫離課程範圍之解答與題目。

本研究設計的 Multi-Agent 架構,結合教材資料庫 (junior student textbook corpus) 與國中英語題庫 (junior high school English question bank),使系統具備:

- 精準秒準 對應國中學生學習進度
- 依據課綱難易度適當出題
- 避免出現如未修習文法,舉例來說目標學生是國一下的學生,故不會有「未來式」或「現在完成式」等學習階段尚未涵蓋之題目。

實驗證明該系統能提供 準確性更高、符合教學實務需求、且 動態生成即時練習題的學習輔助服務。

此研究亦提供 Multi-Agent 協同工作於智慧教育領域的實證案例,具備高度實務推廣價值。

系統架構

- User \rightarrow Agent1 \rightarrow Agent2 \rightarrow User
- User 輸入問題
- Agent1:從 Chroma DB 檢索教材與題庫 → 生成英文解答
- Agent2: 閱讀 Agent1 回答 + 題庫 → 產出 5 題相關選擇題
- 回傳 User:整合解答 + 練習題

技術實作

	技術	說明	
-			
	LLM	OpenAI GPT-4o	
	Database	Chroma Persistent Vector Store	
	Embedding	OpenAI text-embedding-3-small	
	API Server	Flask	
	Frontend	原生 HTML + JS	
	State Memory	Flask Session 保存題目記錄	
	語料	康軒、翰林、南一之教材 PDF + 題庫 json	

功能流程圖

User → POST /ask_multiagent_rag

Agent1:查詢 Chroma manuals + question_bank

▼ 產生英文解答 -

Agent2:產生5題相關英文選擇題

o 傳 User

AI 助教對話介面

🙋 數量不定代名詞是什麼?

助教解答:

數量不定代名詞(quantitative indefinite pronouns)是用來表示不確定數量的代名詞,通常用來 指代不確定的某些人或事物,而不需要具體列出數量。例如:

- "Some" 表示一些,可能的例子有 "Some of the cookies are missing."
- "Many" 表示許多,如 "Many students like ice cream."
- "Several" 指幾個,如 "Several were chosen for the team."

這些詞可以用來取代具體的數字,以提供更多的靈活性和一般性。它們的特點是不確定性,能夠 在不需要精確數量的情況下使用。

🖹 題目練習:

【教材內容】數量不定代名詞(quantitative indefinite pronouns)是英文語法中的一個重要概念。它們用來表示不確定或未具體指定的數量,且不需要詳加列舉。這些代名詞包括 "some," "many," "several," "few" 等。在句子中,它們可以取代具體的數字或確切的數量,從而增強語句的靈活性和普遍性。

- 1. Which of the following qualitative indefinite pronouns would you use to indicate a large and uncertain number?
- a) Few
- b) Any
- c) Many
- d) None
- 2. Choose the correct sentence using a quantitative indefinite pronoun:
- a) He has eaten a cookies.
- b) Some of the cats are black.
- c) There is any milk left.
- d) Each have their own room.
- 3. What is the main purpose of using quantitative indefinite pronouns?
- a) To specify exact numbers
- b) To describe certainty
- c) To indicate uncertainty in quantity
- d) To describe specific people
- 4. Identify the quantitative indefinite pronoun in the following sentence: "Several of the participants arrived early."
- a) Participants
- b) Arrived
- c) Several
- d) Early
- 5. Which sentence correctly uses a quantitative indefinite pronoun?
- a) He saw every birds in the tree.
- b) Many of the answers were incorrect.
- c) None people were at the park.
- d) A few of rain is expected tomorrow.

● 助教解答:

1. 答案:c) Many

解析:Among the given options, "many" is used to indicate a large and uncertain number, making it the correct choice for the question.

2. 答案:b) Some of the cats are black.

解析: Option b uses "some," a quantitative indefinite pronoun, correctly to indicate an unspecified number of cats that are black. Other options either have grammatical errors or do not use a quantitative indefinite pronoun correctly.

3. 答案: c) To indicate uncertainty in quantity

解析:Quantitative indefinite pronouns are used to indicate an uncertain quantity, providing flexibility and generality in communication.

4. 答案:c) Several

解析:In the sentence, "several" is the quantitative indefinite pronoun that indicates an unspecified number of participants.

5. 答案:b) Many of the answers were incorrect.

解析: Option b correctly uses "many," a quantitative indefinite pronoun, to indicate an unspecified large number of answers that were incorrect. Other options either misuse the pronoun or have grammatical errors.

🖹 題目練習:

(上一題練習題,未重複提供)

🔯 不可數名詞是什麼?

動教解答:

不可數名詞是英文中的一類名詞,這些名詞表示不可分割或無法計數的事物,如「水」(water)、「米」(rice)、「空氣」(air)等。這些名詞通常沒有複數形式,也不使用 "a" 或 "an"。常用「some」、「much」等詞來表示其數量。

例如:

- There is some water in the bottle.
- I don't have much money with me.

不可數名詞主要用來表示整體或一般概念,而不是個體或具體的項目。

🔋 題目練習:

【教材內容】不可數名詞通常指那些不能被單獨計算的名詞,這些名詞涵蓋液體、粉狀物、抽象概念、自然現象、集體名詞等。它們一般不使用數字來計數,而是用量詞或其他描述形式。標示量的方式通常包括單位詞(如一杯、一勺)或通過估量詞(如一些、少量)。

- 1. Which of the following sentences uses an uncountable noun correctly?
- a) She has a car in her garage.
- b) He owns many waters in his pantry.
- c) There is a lot of information available online.
- d) I saw several breads at the bakery.

學術貢獻

- 提出 Multi-Agent RAG 結合檢索+創作+互動學習完整流程
- 實作 Session-Based Memory 讓 AI 可記住上輪題目並自動解題
- 適合 Digital Game-Based Learning, Self-Regulated Learning 教育研究

未來展望

- 整合更多教材類型 (e.g., grammar PDF, listening mp3 captions)
- 增加更多 Agent (Ex. 評分助教、改作文助教)
- 前端介面擴充成 SPA + Charts + Badge System