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Large language model and domain-specific model collaboration for smart education

Key words: Smart education; Large language models (LLMs); Domain-specific models (DSMs); Model collaboration; Multiple knowledge representation (MKR); Intelligent teaching assistant

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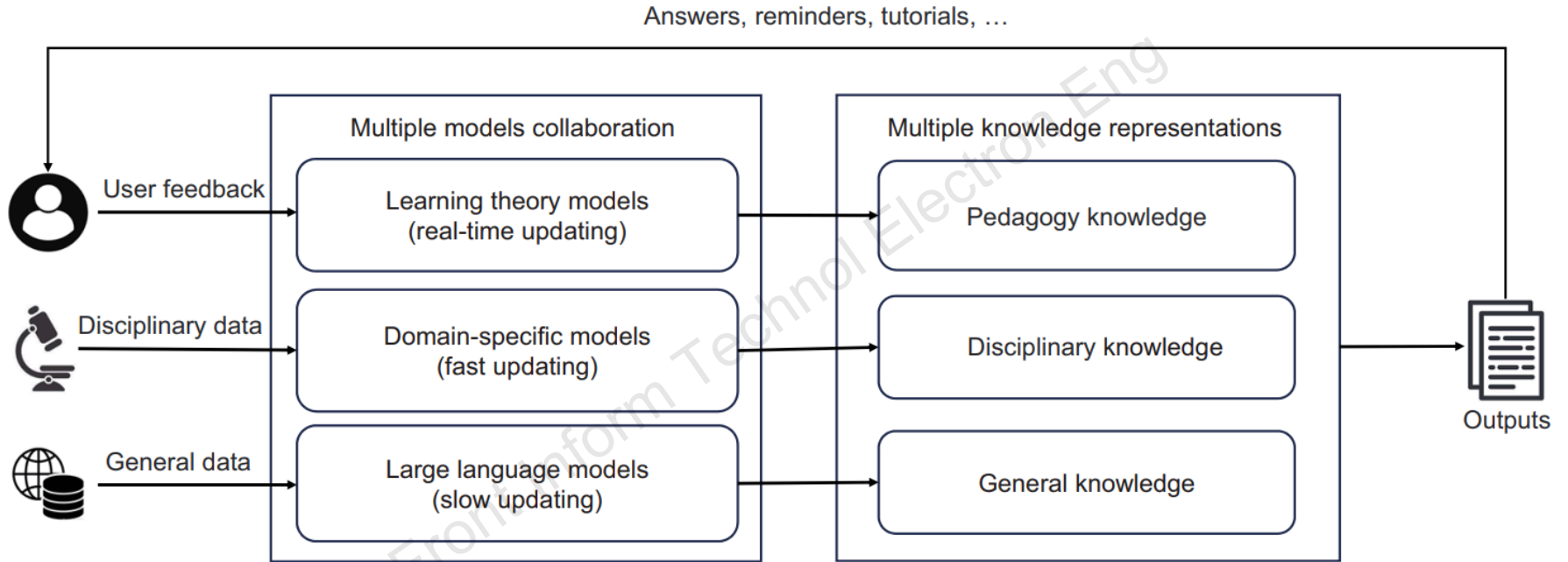
Motivation

- Over the last 30 years, artificial intelligence (AI) has been widely used in education, creating new opportunities for designing productive learning activities and developing better learning applications. In this campaign, both LLMs and DSMs have shown some use in the field of education.
- Nevertheless, LLMs and DSMs have their respective disadvantages. For example, the outputs of DSMs typically adhere to predefined structures but not natural interaction, while LLMs may not exhibit the same level of performance on domain-specific tasks as they do on general ones. This gives us insight into the combination of LLMs and DSMs.

Main idea

- The large language model and domain-specific model collaboration (LDMC) framework combines the strengths of various models, enabling efficient and comprehensive support for educational tasks with MKR.
- By leveraging the extensive knowledge of large domain-general models, LDMC gains an understanding of diverse subject matters.
- Simultaneously, the integration of specialized DSMs ensures that disciplinary knowledge is accurately represented and applied.
- Pedagogy knowledge from learning theory models further enhances the framework's adaptability and efficacy in accommodating individual learning styles and preferences.

Framework



Overview of the large language model and domain-specific model collaboration (LDMC) framework

Method

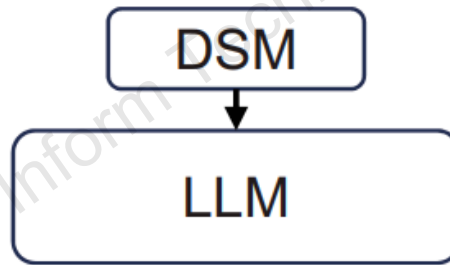
We proposed three cooperative modes of LLMs and DSMs: knowledge injection, knowledge supplementation, and knowledge constraint.

Knowledge injection



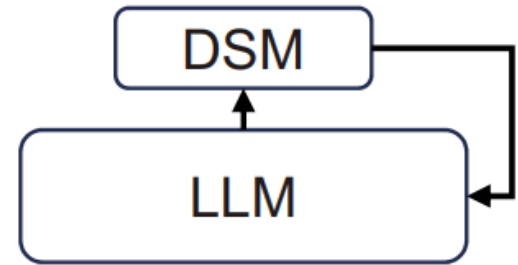
DSMs are seamlessly integrated into LLMs as lightweight learning modules, such as “Adapter.”

Knowledge supplementation



DSMs play as external disciplinary knowledge complementors for LLMs.

Knowledge constraint



Additional constraints from DSMs are put on the LLMs to ensure responses that adhere to the defined domain boundaries.

Applications

Group learning

LDMC offers a wide range of possibilities for facilitating group collaboration, including maintaining goal alignment, sustaining communication vitality, and synchronizing learning progress.



Individual intelligent tutoring

LDMC can tailor educational content to meet the unique needs of each student, helping with math problems, explaining complex concepts, or providing interactive exercises.



Classroom management

LDMC can assist teachers in creating clear and consistent orders, offering guidance on developing comprehensive sets of rules and expectations that are appropriate for the class state.



Major results

Table 1 User study in a group learning scenario

Model	Satisfaction score			Total score
	Instructor	Collaborator	Exciter	
LLM	22	23	14	59
LDMC w/o LSM	21	24	17	62
Full LDMC	25	26	21	72

w/o: without

We conducted a user study with a small-scale group of 30 students in a group learning scenario. The score was increased by 1 if a student was satisfied with the role (instructor, collaborator, or exciter) played by the model, and by 0 otherwise.

Conclusions

- This paper introduces LDMC, a new model collaboration paradigm. In LDMC, LLMs and DSMs are deeply entangled with, and reinforced by, each other, and such collaboration yields MKRs, fostering personalized and adaptive educational experiences.
- Through the method of conducting a user study in the context of group learning, we could ascertain that LDMC represents an advanced and comprehensive educational assistance framework.
- With the continuous advancement of AI, LDMC is poised to offer promising potential in significantly impacting the field of smart education.



Yawei LUO received his Ph.D. degree from Huazhong University of Science and Technology in 2020. He is currently a ZJU 100 young professor with the School of Software Technology, Zhejiang University. He was a post-doctoral researcher with CCAI, College of Computer Science and Technology in Zhejiang University from 2020 to 2023. He was a visiting Ph.D student with ReLER Lab, AAIL, University of Technology Sydney, from 2017 to 2019. His research interests include computer vision, domain adaptation, and 3D reconstruction.



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