Design and Implementation of Knowledge Graph-based AI Assistant for Assisted Teaching and Quizzing

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Abstract: Since the rapid development of Internet technology, a variety of assisted teaching tools have been gradually introduced in the field of education, which have achieved extensive sharing of educational resources and personalised learning experience. However, due to the complexity of the knowledge graph and the dynamics of the educational content, the current assisted teaching system is still facing the dilemma of low answer accuracy, long response time and poor user experience, and how to improve the intelligence level of the system is imminent. Based on this, this paper briefly discusses the design and implementation of an AI assistant for assisted teaching and answering based on knowledge graph, analyses the key technologies and applications of the system, and puts forward a targeted approach to performance evaluation and optimization, with a view to providing a reference and reference for the development of future educational technology.

Keywords: Knowledge Graph; Assisted Teaching; Question and Answer System

1. Introduction

With the rapid development of information technology, the field of education is experiencing profound changes. As an emerging educational technology tool, knowledge graph-based assisted teaching Q&A AI assistants can provide personalised learning support for students and help teachers manage teaching more efficiently. However, current assistive teaching systems still have many challenges in dealing with complex educational content and accurately answering students' questions, such as the construction and updating of knowledge graphs and the accuracy of natural language processing techniques. These problems not only affect the effectiveness and user experience of the system, but also limit its scope of application in practical teaching. Therefore, it is particularly urgent to design and implement a high-performance and high-accuracy knowledge graph-based AI assistant for assisting teaching and answering questions[1] .

2. Knowledge Graph Construction and Management

2.1 Definition and Overview of Knowledge Mapping

Knowledge Graph is a kind of knowledge expression method. Through entities and their associations, it presents the structure of knowledge system. The Educational Scene, it might arrange books like textbooks into a Knowledge Graph with other course info and assignments and such to create a Knowledge Network where kids can find exactly what they need as they study. knowledge graphs' building consists not just of extracting and analyzing text, it includes knowledge classification, linking and fusion as well. This way knowledge mapping creates clear logical linkages within the complexities of the information and helps students to have a clearer understanding of knowledge and to master it. Also thanks to the help of knowledge mapping, ai teacher assistants are able to swiftly find out and pick up pertinent areas of knowledge and make exact answers. As a result, it could increase teaching and studying experiences for all kinds of students. The application domain of the knowledge graph is by no means bound to the purpose of knowledge acquisition; the learning route design, material selection recommendation, personal education, etc., have broad scope for its uses.[1] .

2.2 Construction Method of Knowledge Graph

Construction Methods for a Knowledge Graph, covering which datasets it uses, how those are assembled, and what kind of knowledge it’s drawing out and putting in. The source of

educational resources can be textbooks,online courses,teachers'handouts,students'assignments and so forth. And those scattered data is brought under one roof using data crawling and the call of api interfaces. On the contrary, knowledge extraction technique takes help of entity and relation extraction in order to get main knowhow point from textual matter along with connection between these points including contains, association and same. Ontology building is central to knowledge mapping; it establishes the base architecture of the knowledge system via defining types of entities and type of relationships. While we talk about making connections with knowledge, we can take all sorts of places with our mind and put that onto our own ontologies of our minds for things. It is built with automatic construction methods, manual check and other methods so that it can build an accurate and authoritative knowledge map as well as laying an efficient basis for later usage.

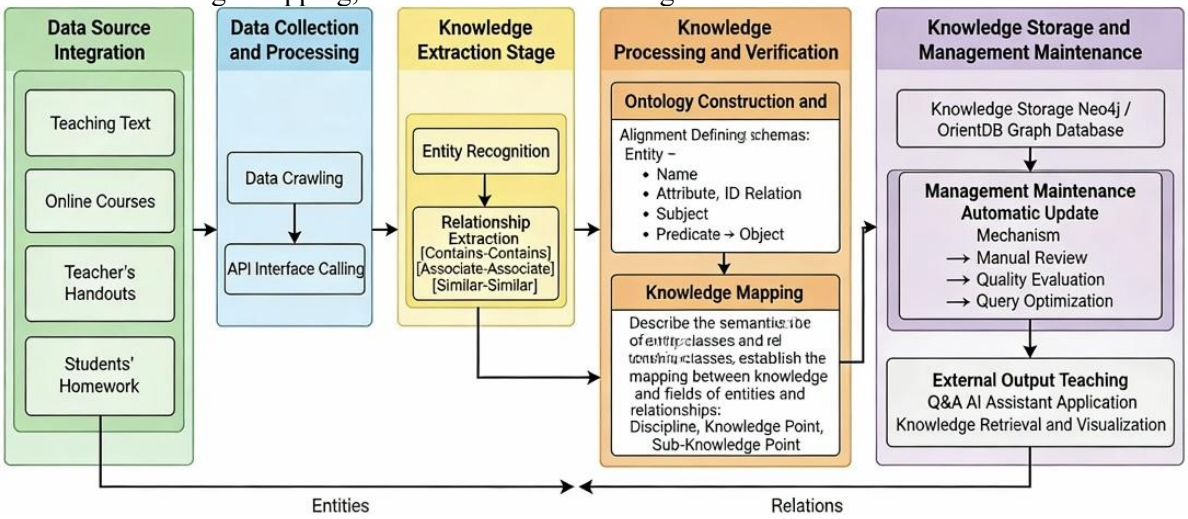

Figure 1. Knowledge Graph Construction and Management Flowchart

2.3 Management and Maintenance of the Knowledge Map

Automatic update maintains up-to-date complete knowledge by constantly acquiring new information via NLP and putting in graph. And the human reviews will be needed after that automatically extracted knowledge is reviewed for correctness and not leading our learners astray with wrong info. Quality evaluation is an essential piece of the managing, which consists of regularly reviewing the accuracy, completeness and consistence of the knowledge graph so as to fit teaching demands. On the storage side we find graph databases like Neo4j and OrientDB which can handle structure knowledge network quite well as well as supporting complicated graph query operation. Query optimization technologies make answer search much faster, they do this by making indexes for the things to be searched more efficiently, making better ways to ask about things that need to be known, so when someone asks a question, you can find the answer quickly. Besides creating a great deal of logging and error solving, there has to be an effective system set to recognize these problems on time and to give users a smooth feeling. With all of these things together, our knowledge graphs should just keep giving us good, dependable info helps out our tutoring questions and answers machine intelligence partner.

3. Natural Language Processing and Dialogue System Design

3.1 Overview of Natural Language Processing Technologies

We can tell the meanings that the person is wanting as well as see how the words fit with what's going on around it just by looking at their questions through NLP. Technical tools like word-segmentation, lexical-annotation, named-entity-recognition, syntax-analysis and semantics-comprehension all work together towards helping this system pull in necessary data from those questions. And do some sentiment analysis about the feeling of a student and give them nice feedback. With the machine translation and multilingual, the AI assistant will be able to help all kinds of students from other language countries too, making it even bigger. Natural language generation tech makes sense out of knowledge graph's structured stuff so it

ends up being easy for students to read.[2] .

3.2 Understanding and Handling Student Questions

System breaks down the students' own language problems into small basic parts through word breaking and explaining important things in each of these small pieces. Named Entity Recognition technology picks up special data like names for people and places to make it simpler for someone else to catch the problem. But syntactic analysis helps us parse sentences for those structures, and then we get the subject-verb-object relationship of questions and get some feel for students' intentions better. The Semantic understanding technique turns students' expression into a semantics representation, by using deep languge modelings and contextual understanding to keep the response consistent and coherent. And I'm just gonna take this sentiment analysis to understand how the student is feeling so that we would be able to do a nicer answer back like "yes, okay".[3] . In the end it will analyze all this and find out by means of its own knowledge graph data and provide an answer. And the result we're giving is an exact, useful response to what's needed. And the result we have now given is some useful, on-topic answer to someone.

3.3 Answer Generation and Recommendation

It's gonna take all the students that's asked me if they could do it and then I would just take those question and match them up to a knowledge node from the knowledge graph and try and find out the best one. The generation process for natural language makes sure that this organized information gets turned into natural sounding sentences, which students can follow without trouble. And then we use that multimodal fusion, which takes lots of kinds of stuff, like how things are written and pictures and movies, and combines them so they give even better and more straightforward replies[4] .

Recommendation algorithm predict what student may like and need by looking at the history of their questions and record of studying, and give them things related to learning. At the same time, it will keep on optimizing the answer generating and recommendating ways thanks to real - time feedbacks to make sure the students can always have the very best learning feel every single time they do these operations.

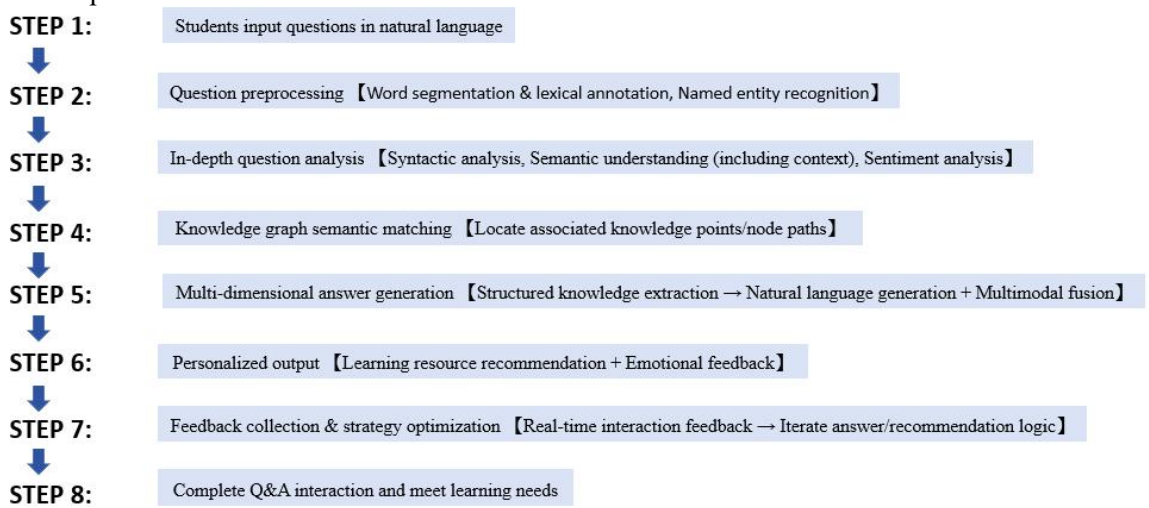

Figure 2. Flow Chart of Natural Language Question Answering Combined with Knowledge Graph

4. System Evaluation and Optimisation

4.1 System Performance Assessment

Aspects such as being accurate and fast response time and having good user experience. Accuracy: We will be comparing what's given back by the system to standard or expert answer, we'll check if this give us correct answers. Response time instead gauges the amount of waiting time needed by the system to deal with pupil inquiries in order to improve the feeling of use and make the user feel much nicer and faster. User evaluation is carried out via questionnaires and comments gathered by the person experiencing it in order to learn about their satisfaction concerning its user interface and interactions as well as whether answers were satisfactory. Also the evaluation contains its robustness and scalability, trying various settings for it and huge

count of people using it at once.

4.2 Feedback Mechanisms and Continuous Optimisation

System will receive many users' feedback by different ways such as on-line questionnaire, comments, etc., it can help the development teams understand what their end-users need & feel when they use the product. Real – time feedback makes it possible for this to be done right now upon every exchange, so that the quality and precision of replies might be recognized through monitoring a person's actions afterwards alongside how effectively any given issue has resolved itself. After receiving these kinds of responses, we have been able to put machine learning algorithm and continuously try to modify the shape and content within the knowledge graph so that it would better align with students asking questions.[5] . As for our development team we are continuously improving on our systems knowledge database by adding in the most recent training materials and researching results so as to keep all of this information fresh and current.[6] .

4.3 Ethical and Privacy Issues

The system has to follow data safety laws closely so that all the details from our users' accounts which get gathered up along with anything that might have their private info should both disappear before we can see it again as well as not leak over somewhere where we don't want them going[4] . The other part of your sentence is that you're supposed to get a little transparency about what kind of data use policy there is, just tell me where they keep my stuff safe and what's going on with it. And we have to make sure that we follow our ethics when building up this new knowledge graph thing and making changes so that nothing inside would actually be correct but also very fair and balanced for each individual person. Also has mechanisms in place to stop misuse and not produce bad answers or controversial ones. As more techy stuff goes everywhere around society, people who use things aren't just fine when things work right and conveniently, they want super-duper good stuff behind it, like being ethical and protecting stuff that belongs to folks (privacy). Therefore the development team must make ethical/privacy issues their focus rather than just another feature in order to really improve trust among its customers. The next big step we can take in making things possible in the world we've created is by setting up an ongoing structure for checking out both those rules regarding doing what is morally acceptable, as well as whether or not personal information stays hidden away from others seeing it.[7] .

5. Conclusion

In summary, the knowledge graph-based AI assistant for assisted teaching and quizzing shows great potential in enhancing the quality of education and personalised learning experience, but the current system still faces many challenges in knowledge graph construction, natural language processing and data privacy protection. In the future, the algorithm should be further optimised to enhance the accuracy and responsiveness of the system, and ethical and privacy protection should be strengthened to ensure that it can achieve better results in its wide application in the field of education[8] .

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References

[1] Li Mei, Cai Guanyin, Ma Xian, et al. Research on virtual reality technology based on artificial intelligence to assist college basketball teaching [J]. Sports goods and technology, 2024, (20):157-159.

[2] Dong Fang. Analysis of personalised

recommendation system for teaching resources based on artificial intelligence assistance [J]. Electronic Technology, 2024, 53(10):148-149.

[3] Xing C, Yun L, Feng S. Predict, pretrained, select and answer: Interpretable and scalable complex question answering over knowledge bases [J]. Knowledge-Based Systems, 2023, 278.

[4] V. S T, C. P R R. A novel technique using graph neural networks and relevance scoring to improve the performance of knowledge graph-based question answering systems [J]. Journal of Intelligent Information Systems, 2024, 62(3):809-832.

[5] Zhou, X., Zhang, Z., Xie, X. et al. Deep learning based knowledge tracing in intelligent tutoring systems. Sci Rep [J]. 15, 21395(2025).

[6] Zheng Yao, Xia Tingting. Design and implementation of an AI assistant for assisted teaching and answering questions based on knowledge graph [J]. Information and Computer (Theoretical Edition), 2024, 36(02):235-237.

[7] Chen Fei. Data security opportunities and challenges in the AI era [J]. China Science and Technology Information, 2025, (15):156-158.

[8] Wang L, Wang T, Zhou H T, et al. Course-Oriented Knowledge Service-Based AI Teaching Assistant System for Higher Education Sustainable Development Demand [J]. Sustainability, 2026, 18(2):807-807.

