

Research on Teaching Innovation of Machine Learning Courses Synergistically Empowered by Knowledge Graphs and Intelligent Agents

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Abstract: Against the background of the intelligent era, fundamental changes have taken place in talent requirements and job-post demands. Traditional teaching modes are confronted with practical problems including fragmented knowledge, insufficient adaptability to learning situations, weak personalized guidance and single-faceted teaching evaluation, which can hardly meet the training demands for high-order innovative talents under intelligent-education backgrounds. On this basis, this paper focuses on exploring teaching-innovation strategies for machine-learning courses synergistically empowered by knowledge graphs and intelligent agents, so as to provide theoretical support for the intelligent teaching reform and the implementation of personalized education of machine-learning courses in colleges and universities.

Keywords: Machine-learning course; Intelligent agent; Knowledge graph; Artificial intelligence

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1. Introduction

As a core major course for artificial-intelligence, big-data and computer-related majors in colleges and universities, machine-learning courses undertake the important educational function of cultivating students' algorithm-oriented thinking, model-building capabilities and literacy in applying intelligent technologies. Featuring technical advantages of structured knowledge organization, associative logical sorting and visualized system presentation, knowledge graphs can effectively sort out the complex knowledge system of machine learning and help students establish systematic and hierarchical knowledge frameworks^[1]. Intelligent agents possess core characteristics including autonomous interaction, learning-situation perception, intelligent adaptation and dynamic tutoring, which can realize precise, adaptive and full-process teaching services. The teaching-innovation mode empowered by the synergy of the two can remedy inherent drawbacks of traditional teaching systems and build a new teaching paradigm featuring deep integration of structured-knowledge teaching and personalized intelligent tutoring.

2. Teaching advantages of machine-learning courses synergistically empowered by knowledge graphs and intelligent agents

2.1. Knowledge graph

A knowledge graph is a structured knowledge-organization and-representation system constructed based on semantic-network theory, ontology ideology and big-data knowledge-mining technologies. It serves as a core technical carrier for realizing structured knowledge storage, semantic association and visualized presentation in the field of artificial intelligence. In the education sector, knowledge graphs can accurately define difficulty levels, prerequisite dependencies, progressive logics, and application scopes of disciplinary knowledge. For instance, adopting the “core-knowledge layer + cutting-edge-expansion layer”, a knowledge graph can cover six types of content: basic theories, key algorithms, core concepts, tool applications, industrial cases and cutting-edge technologies. It clarifies internal correlations and supporting relationships among different knowledge modules and constructs a complete disciplinary-knowledge logical system ^[2].

2.2. Intelligent agent

An intelligent agent refers to an intelligent subject system with autonomy, interactivity, adaptability and intelligence, which is built upon artificial-intelligence algorithms, machine-learning models, perceptual-computing technologies and autonomous-decision-making mechanisms. It acts as a core intelligent carrier to realize personalized learning guidance, adaptive teaching and dynamic learning-situation services in intelligent-education scenarios. Different from traditional intelligent tools, intelligent agents are equipped with independent capabilities for environment perception, information collection, data analysis, logical judgment, autonomous decision-making and dynamic adaptation. Without continuous manual intervention, they can actively perceive changes in external scenarios, user behavioral characteristics and dynamic learning status ^[3]. Meanwhile, relying on course knowledge graphs and Q&A knowledge bases, intelligent agents can identify, retrieve and respond to questions concerning concept interpretation, code debugging and case analysis. Generated results shall be compared with standard expressions in the graph; re-retrieval, revision or teacher verification shall be performed when necessary.

2.3. Teaching advantages of machine-learning courses synergistically empowered by knowledge graphs and intelligent agents

First of all, machine-learning courses feature high theoretical abstraction and strong logical complexity. Students show remarkable individual differences in mathematical foundations, logical thinking, algorithm comprehension and practical-operation capabilities. The unified and homogenized traditional teaching mode fails to adapt to students’ personalized learning rhythms and differentiated growth demands, making it difficult to achieve the educational goal of teaching students in accordance with their aptitude. Through two-way synergy between refined knowledge graphs and intelligent agents, the intelligent teaching system can automatically adapt to different students’ learning rhythms, dynamically adjust the difficulty of knowledge delivery, teaching progress, learning priorities, and training content. It consolidates underlying theoretical systems for students with weak foundations, and pushes high-order algorithm-expansion and innovative-application contents for high-ability students, so as to realize hierarchical teaching, precise instruction and aptitude-oriented education ^[4].

Secondly, leveraging the technical strengths of knowledge graphs and intelligent agents, university teachers can make up for drawbacks such as insufficient interaction and delayed guidance in traditional

teaching, and comprehensively improve teaching efficiency and educational outcomes of machine-learning courses. Specifically, on the one hand, based on the knowledge-association logic of knowledge graphs, intelligent agents can conduct hierarchical decomposition, logical sorting, and precise interpretation for various machine-learning theoretical questions, algorithm puzzles, and derivation difficulties raised by students. They output not only standardized answers but also restore internal correlations and derivation logics of knowledge points, guiding students to establish scientific problem-solving thinking and disciplinary logics.

On the other hand, the combination of intelligent agents and knowledge graphs can dynamically track students' learning processes, actively identify high-frequency difficult points and error-prone knowledge points, and push supporting interpretation resources, logical-sorting content, and targeted training materials in association with knowledge graphs. This realizes the transformation from passive Q&A to active learning guidance^[5].

Thirdly, the integration of knowledge graphs and intelligent agents can not only deeply bind theoretical knowledge with corresponding model training, code implementation, experimental design, parameter optimization and scenario-based applications, but also automatically match practical training, experimental projects and algorithm-application tasks of adaptive difficulty levels after students finish learning corresponding theoretical modules, guiding students to transform theoretical cognition into practical capabilities in a timely manner.

3. Existing problems in traditional machine-learning course teaching

3.1. Single and rigid teaching mode

Machine-learning courses are characterized by dense, difficult knowledge points, abstract and complex algorithm logic, as well as lengthy formula-derivation chains. Students tend to suffer from persistent fragmented cognitive confusion and logical puzzles. However, traditional Q&A modes feature obvious lag and passivity. They cannot give real-time responses and precise decomposition to students' immediate learning questions, leading to continuous accumulation of students' cognitive difficulties, superficial knowledge comprehension and barriers to in-depth learning^[6]. Meanwhile, under the traditional single and rigid mode, teachers cannot fully grasp every student's real-time learning status, frequently occurring error-prone points, and core cognitive blind spots. Targeted thinking guidance and difficulty decomposition are hard to carry out, which severely undermines the accuracy and effectiveness of interactive education.

3.2. Severe homogenized teaching

Machine-learning courses integrate multidisciplinary knowledge including advanced mathematics, linear algebra, probability theory and computer programming. They boast high theoretical abstraction, complex logical derivation and high practical thresholds. Students have inherent hierarchical differences in mathematical-physical foundations, programming capabilities, logical-thinking literacy and algorithm-comprehension speed. Accordingly, their knowledge-reception efficiency, difficulty distribution, learning demands and capacity-improvement potential show prominent personalized features^[7]. Nevertheless, traditional machine-learning courses adopt a homogenized teaching mode with unified progress, content, and standards. The whole teaching-implementation process lacks hierarchical design and personalized-adaptation mechanisms, and cannot accommodate students' differentiated cognitive foundations, thinking abilities and learning rhythms. Hence, the modern educational concept of teaching students in accordance with their

aptitude is hard to implement.

3.3. Disconnection between theoretical teaching and practical teaching

The core educational feature of machine-learning courses lies in the high integration of theory and practice. Cognitive deepening and capability transformation for various algorithm principles, model logics, and mathematical-physical theories rely on experimental practice, code implementation, model training, parameter tuning, and result verification. At present, practical-teaching phases in some colleges and universities are mostly dominated by fixed experimental projects, standardized practical-operation procedures and copy-style training. They lack associated review and in-depth application of theoretical knowledge. Students mechanically complete code execution and model training, and cannot solve practical problems combined with theoretical knowledge^[8].

4. Teaching-innovation strategies for machine-learning courses synergistically empowered by knowledge graphs and intelligent agents

4.1. Build a theory-practice integrated educational mechanism to improve teaching effectiveness

The core of talent cultivation for machine-learning courses consists in the organic unification of theoretical cognition and engineering practice. Promoting the synergy between knowledge graphs and intelligent agents can break educational barriers between theory and practice from multiple dimensions, including knowledge association, process guidance, dynamic adaptation, and two-way verification, to realize all-round education. Specifically, first of all, teachers can adopt knowledge graphs to build a mapping system associating theoretical knowledge points with practical projects. Abstract algorithm principles, mathematical-physical derivation logics and model-operation mechanisms are deeply bound to corresponding practical-operation links, which clearly presents the internal logic that theory guides practice and practice verifies theory, forming an integrated knowledge network of theoretical knowledge and practical capabilities^[9].

Secondly, teachers can build a theory-practice association system relying on intelligent agents to realize dynamic connection and process guidance for theoretical learning and practical training. After students finish learning corresponding theoretical modules, practical-training contents of adaptive difficulty levels are automatically matched to guide students to timely realize knowledge implementation and practical-ability transformation.

Finally, establish a collaborative-feedback mechanism to guide students to analyze practical phenomena, judge model effects, troubleshoot operational deviations and optimize training parameters based on theoretical logics, so as to realize theoretical tracing and principle review of practical processes^[10]. On this basis, students' capabilities for algorithm comprehension, model construction, parameter optimization and engineering application are continuously tempered, and the educational effectiveness of integrating knowledge with practice for the course is comprehensively improved.

4.2. Optimize the teaching-resource system to meet industrial talent standards

Teaching resources act as the core carrier for course-teaching implementation. The completeness, timeliness, structurality and professionalism of the resource system directly determine the depth and quality of course teaching. Integrating the technical strengths of knowledge graphs with intelligent agents can construct a

new type of teaching-resource system characterized by structurality, dynamism, three-dimensionality and iterativeness^[11].

On the one hand, intelligent technologies can capture cutting-edge scientific research achievements, new-type algorithm models, industrial technical standards and mainstream application technologies in the machine-learning field in real time. Dynamic screening, intelligent updating and real-time iteration of teaching resources are realized. Outdated, obsolete and poorly-adapted traditional teaching contents are continuously eliminated, and cutting-edge, innovative and practical new teaching resources are supplemented. On the other hand, a well-structured, logically rigorous and interconnected network-style teaching-resource framework can be independently built. Refined tagging processing and classified adaptation of teaching resources are implemented, and resources are precisely classified according to difficulty levels, theoretical attributes, practical attributes and capability-corresponding relationships of knowledge points^[12].

4.3. Precisely locate students' learning situations and implement personalized learning

The essence of personalized teaching lies in respecting students' differences in cognition, capabilities and development, and realizing precise adaptation of teaching contents, teaching rhythms, teaching paths and teaching tasks. Combined with the structured-knowledge base of knowledge graphs and the dynamic learning-situation-perception capability of intelligent agents, university teachers can build a new intelligent teaching mode featuring full-process self-adaptation, hierarchization and personalization, and thoroughly achieve the high-order educational goal of teaching students in accordance with their aptitude for machine-learning courses.

The application of knowledge graphs can provide a refined, hierarchical and tagged knowledge-resource library for personalized teaching. All course knowledge points are graded by difficulty, classified by attributes, bound to scenarios and correlated with capabilities, forming a modular knowledge-resource system that can be split, combined and adapted^[13]. Based on global learning-behavior perception technologies, intelligent agents collect multi-dimensional data in real time, including students' knowledge-mastery progress, cognitive status, learning-interaction behaviors, training-completion quality and weak knowledge dimensions. With the help of algorithm modeling, dynamically updated refined individual learning-situation portraits are generated to accurately judge different students' cognitive levels, capability hierarchies, and development demands.

Based on the two-way synergy between structured resources of knowledge graphs and precise learning-situation portraits from intelligent agents, teachers can construct a three-stage progressive path of "basic understanding-project practice-innovation expansion" centered on "from understanding to application", covering pre-class preview, in-class interaction and after-class consolidation. For example, the intelligent platform can automatically generate personalized learning paths according to teachers' instructions, dynamically adjust the difficulty of teaching content, priorities of knowledge push, in-class teaching rhythms, and after-class training tasks. It provides basic, consolidative, and preparatory teaching content for students with weak foundations, and pushes expanding teaching content such as high-order algorithms, innovative models, and cutting-edge applications for high-ability students, so as to realize hierarchical teaching, precise instruction, and demand-oriented education^[14].

4.4. Implement task-oriented teaching mode and strengthen students' practical capabilities

The task-oriented teaching mode can break the limitations of traditional passive, indoctrinating and theoretical teaching. It establishes an active, immersive and systematic teaching form with task-driving as the core,

capability cultivation as the goal and independent inquiry as the path. Relying on the strengths of knowledge graphs, teachers can generate a complete knowledge-logic diagram for machine-learning courses. Combined with hierarchical relationships, progressive rules and capability-cultivation goals of knowledge points, systematic, gradient-based and modular teaching-task design is completed, such as basic-cognition tasks, principle-exploration tasks, model-analysis tasks and algorithm-application tasks. It ensures that various teaching tasks are closely consistent with course-knowledge logics and adapt to students' cognitive laws^[15]. Intelligent agents can provide associated knowledge, debugging prompts and process feedback during task execution. Afterward, generated high-frequency difficulties and weak points, upon teacher review, feed back to update graphs, resources and teaching tasks, so as to form an effective closed loop for task-oriented teaching.

5. Conclusion

To sum up, against the contemporary backdrop of rapid development of artificial-intelligence technologies, machine learning, as one of its core technologies, has become an important course for computer and artificial-intelligence majors in many colleges and universities. Knowledge graphs and intelligent agents reshape new paths for machine-learning course teaching. By adopting strategies including building a theory-practice integrated educational mechanism, optimizing the teaching-resource system, precisely locating students' learning situations and implementing the task-oriented teaching mode, we can effectively improve the systematicness, pertinence and effectiveness of course teaching, help students construct a complete algorithm-knowledge system, and temper their engineering-practice and model-innovation capabilities.

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