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Optimizing the Big Data Curriculum by Integrating Artificial Intelligence Courses to Enhance College Students' Professional Literacy

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Abstract: Recognizing the growing significance of big data and related technologies, an increasing number of colleges and universities in China have introduced specialized majors focused on this rapidly advancing field. With valuable experience in educating students in these majors and facing emerging challenges, it has become essential to optimize the curriculum for big data-related programs to ensure students are well-prepared for industry demands. To better prepare students for the job market, Chinese colleges and universities have agreed on the importance of adopting strategies such as integrating Artificial Intelligence courses. It is hence crucial to explore innovative strategies for optimizing the curriculum for big data-related majors through the integration of Artificial Intelligence-focused courses. In this paper, we examine and analyze strategies for enhancing the curriculum of Data Science and Big Data Technology by implementing Artificial Intelligence course integration. Our goal is to improve the professional literacy of college students, enabling them to thrive in a data-driven world. Through our research, we propose a series of curriculum enhancements aimed at aligning educational outcomes with evolving industry needs, fostering essential technical skills in data science and big data analytics among students. An case study, via a comprehensive quantitative analysis of teaching data for Data Science and Big Data Technology, confirms the validity of the proposed strategies.

1. Introduction

In response to the growing demand for college graduates specializing in big data, an increasing number of universities and colleges in China, along with institutions globally, have introduced big data-related programs or majors to meet industry needs. For example, Suqian University, where we are employed, has introduced the Data Science and Big Data Technology major. As colleges and universities gain more experience in teaching these disciplines and encounter new technological challenges, it is necessary to optimize the curricula of majors related to big data[1].

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines, enabling them to perform tasks such as learning, problem-solving, decision-making, and pattern recognition. AI encompasses a range of technologies, including Machine Learning (ML), natural language processing, and computer vision, which allow systems to analyze data, adapt to new information, and improve performance over time. AI is transforming industries, driving innovations in automation, healthcare, finance, and more, enhancing efficiency and enabling new capabilities. In the past ten years, the world has witnessed the rapid development of AI. The connection between AI and Big Data lies primarily in how AI leverages the vast amounts of data generated across various sectors to enhance decision-making, automation, and predictive analytics. The Big Data major focuses on the collection, storage, processing, and analysis of massive datasets that are too complex for traditional data management tools. These datasets include structured and unstructured data from sources such as social media, sensors, customer interactions, and more. In contrast, AI focuses on developing algorithms and models that enable machines to simulate human-like intelligence. In the context of a Big Data major, integrating AI is essential because it allows students to understand how large-scale data can be transformed into actionable insights. For example, ML algorithms are applied to big data sets to uncover hidden patterns, perform predictive analytics, and optimize business processes. AI enhances Big Data by providing tools that automate data analysis, enabling faster and more accurate decision-making, which is vital in industries that require real-time analysis. Moreover, as the amount of data continues to grow, the demand for professionals who can combine both AI and Big Data skills is increasing. Students studying Big Data are increasingly being trained to use AI techniques to manage, analyze, and interpret large datasets, preparing them for careers where they can bridge the gap between data science and intelligent systems. Integrating AI into the Big Data curriculum helps future professionals stay ahead in an ever-evolving job market.

In the literature, there are several references that provide a comprehensive overview of the strategies and trends shaping modern curricula in majors related to big data. These references provide valuable insights into the optimization of curricula in higher education, particularly in the context of big data, data science, and interdisciplinary education. Wang et al. [1] emphasize the importance of Industry-Education Integration to enhance professional literacy in big data majors, highlighting how collaboration between industry and academia can better prepare students for real-world challenges. Similarly, Li et al. [2] explore curriculum construction in mobile big data technology, focusing on the integration of innovation, entrepreneurship, and ideological education to foster well-rounded graduates. Chen [3] contributes to the on-going discourse on curriculum development by discussing the application of the Outcome-Based Education (OBE) concept in data science and big data technology programs or majors. Zhang et al. [4] address the need for interdisciplinary training, advocating for foundational courses in data analysis technology to bridge the gap between different engineering disciplines, enhancing the relevance of curricula to current industry demands. Wang et al. [5] examine how optimizing curricula in Mathematics Education can boost students' innovation literacy, further illustrating the broader implications of curriculum reform for improving critical thinking and problem-solving skills.

A review of the existing literature reveals a notable gap in research regarding the optimization of the curriculum of majors related to big data through the integration of AI. To address this gap, the present study aims to explore the optimization of the curriculum of majors related to big data by incorporating AI, with the goal of enhancing the professional literacy of college students.

The rest of the paper is organized as follows. In Section 2, we explain in detail the curriculum's role in fostering the professional literacy of college students. In Section 3, we propose several strategies for optimizing the curriculum of the Data Science and Big Data Technology major through incorporating AI courses. In Section 4, we perform an empirical study based on our teaching team's experience. In Section 5, we present several concluding remarks.

2. The curriculum's impact on developing the professional literacy of college students

In this section, we are devoted to examining the curriculum's crucial role in shaping key professional literacy for college students majoring in Data Science and Big Data Technology. A thoughtfully structured curriculum not only delivers knowledge but also prepares students with the skills and qualities required to succeed in their careers. By aligning academic material with industry needs, the curriculum helps close the gap between theory and practice, promoting literacy such as critical thinking, communication, collaboration, and flexibility. This section will explore how curriculum decisions impact students' preparedness for the workforce and how these literacy foster continuous learning and career growth.

2.1. The curriculum provides resources for college students to undergo systematic training

The curriculum for the Data Science and Big Data Technology major is structured to offer a systematic sequence of courses that enables college students to thoroughly understand the field, thereby enhancing their professional literacy. While higher education serves many purposes, one of the most important is to help students improve their professional skills. The curriculum integrates all the resources provided by a colleges or universities, playing a key role in developing students' professional literacy. As such, the curriculum for the Data Science and Big Data Technology major is vital in cultivating these literacy in students.

2.2. The curriculum helps college students learn theoretical knowledge in structured manners

For the Data Science and Big Data Technology major, the curriculum includes a series of theoretical courses that cover various essential aspects of data science. These courses are generally divided into several modules: Mathematics, computer technology applications, foreign language applications, and core courses in philosophy, literature, ethics, and related areas. Given the increasing globalization of the future world, foreign language courses are crucial for college students. It is well-recognized that universal courses in literature, philosophy, ethics, and similar subjects are vital for students in science and technology majors, as they help improve skills like innovation, critical thinking, collaboration, and teamwork. Moreover, the Mathematics and computer technology application modules are critical for the Data Science and Big Data Technology major. In conclusion, the curriculum enables college students to systematically learn theoretical knowledge pertinent to data science and big data technology.

2.3. The curriculum aids college students in acquiring practical experience and skills

For college students, gaining practical experience and skills is essential for both academic and professional growth. In fields like Data Science and Big Data Technology, courses such as Data Mining, ML, Data Analysis and Visualization, and Database Management are pivotal in providing students with the hands-on skills required for success. These courses bridge theoretical learning with practical applications, preparing students for the evolving challenges of a data-driven world and equipping them with critical problem-solving abilities. Data Mining teaches students techniques to uncover patterns in large datasets, while ML introduces algorithms that enable computers to learn from data. Data Analysis and Visualization helps students interpret data and convey insights visually, while Database Management equips them with essential skills for designing and querying databases using SQL. The inclusion of these courses in the curriculum ensures that students majoring in Data Science and Big Data Technology gain the practical experience, technical expertise, and skills needed to excel in their careers.

3. Approaches for refining and optimizing the curriculum of the Data Science and Big Data Technology major through the integration of AI

In this section, we discuss strategies for enhancing the curriculum of the Data Science and Big Data Technology major by leveraging AI. As the fields of data science and big data evolve rapidly, it is crucial to ensure the curriculum remains relevant and aligned with current technological advancements and industry needs. AI can help college students gain theoretical knowledge, along with innovative tools and methodologies that are essential for practical applications and the development of professional literacy. This section will explore various strategies for curriculum enhancement, including integrating ML technologies, offering courses on predictive analytics, introducing real-time big data processing techniques, incorporating AI model optimization techniques, and facilitating collaborative AI and big data projects.

3.1. Integrate ML modules

In a Data Science and Big Data Technology major, integrating ML modules into the curriculum is essential for developing practical expertise in applying algorithms to large datasets. These modules expose students to a wide range of ML techniques, including supervised and unsupervised learning, decision trees, clustering, and neural networks. By engaging with hands-on projects, students learn how to train, test, and deploy models using real-world data, helping them develop the skills necessary to transform raw data into actionable insights. For example, students could work on datasets from industries like healthcare, retail, or finance, applying algorithms to detect patterns, classify data, or predict outcomes. This experience with ML in the context of big data is crucial because students will learn how to scale models to handle large volumes of complex data, a common challenge in data science roles. These modules also familiarize students with popular ML tools such as TensorFlow, PyTorch, and Scikit-learn, ensuring that they are proficient in the industry-standard platforms used for data analysis and modeling. This hands-on expertise is vital for students to transition smoothly into data science roles upon graduation.

3.2. Offer courses on predictive analytics

Predictive analytics, as a part of the Data Science and Big Data Technology major, teaches students how to use AI to forecast trends, identify patterns, and make data-driven decisions within large datasets. In these courses, students learn to apply ML models, such as regression analysis, time series forecasting, and ensemble methods, to predict future outcomes based on historical data. For instance, students might work on projects where they predict customer behavior, sales performance, or market fluctuations, utilizing past data to create models that make accurate future predictions. Predictive analytics is essential in industries like finance, marketing, healthcare, and manufacturing, where data-driven decision-making is vital for improving profitability, mitigating risks, and driving business growth. Students also gain hands-on experience with important data preparation techniques, such as data cleaning, normalization, outlier detection, transformation, and feature engineering, which are critical to ensure that models perform well on real-world data. These techniques help students optimize data quality, which leads to better model accuracy and generalization. They explore advanced strategies like ensemble learning, hyper-parameter tuning, and model selection to further improve their models. By mastering predictive analytics, students are equipped to solve practical business problems, such as optimizing marketing strategies, managing financial risks, improving customer retention, forecasting product demand, or streamlining supply chains, making them highly competitive in the job market. Their ability to develop and deploy robust predictive models will make them valuable assets to any data-driven organization.

3.3. Introduce real-time big data processing techniques

In the era of Internet of Things (IoT), real-time big data processing is increasingly important. Introducing these techniques within a Data Science and Big Data Technology major teaches students how to process data as it is generated, allowing for timely decision-making in fast-paced environments. Students are trained to use platforms like Apache Kafka, Apache Flink, and Apache Spark to process streaming data and apply ML models that adapt in real-time. This capability is crucial for applications such as fraud detection and autonomous vehicles. By combining big data technologies with AI, students learn to handle high-velocity data streams and develop models that can adjust in response to incoming data. For example, they might work on a project where they build a recommendation system that updates in real-time based on user behavior. Real-time data processing not only enhances students' technical skills but also helps them understand the challenges of latency, data consistency, and scalability in real-time analytics, preparing them for roles in industries that require instant insights and actions. These skills are essential for working with emerging technologies in sectors like smart cities, healthcare, and supply chain management.

3.4. Incorporate AI model optimization techniques

AI model optimization should be included to be as a critical component of the Data Science and Big Data Technology curriculum, as it teaches students how to fine-tune ML algorithms to handle large datasets efficiently. In a big data context, it's not enough for models to simply be accurate; they also need to be scalable and perform well even as data volumes grow. Students are introduced to optimization techniques such as hyper-parameter tuning, cross-validation, and feature selection to enhance model accuracy and reduce over-fitting. For example, students might work on optimizing a classification model to handle millions of records, ensuring that it performs well in terms of both speed and precision. Additionally, they learn to leverage advanced algorithms like gradient boosting or deep learning architectures, optimizing them for both computational efficiency and performance. As big data continues to expand in complexity, students with expertise in AI model optimization are highly sought after, as they are equipped to design models that are not only accurate but also efficient and capable of scaling to meet the demands of modern industries.

3.5. Facilitate collaborative AI and big data projects

Collaborative projects are a key element of the Data Science and Big Data Technology major, allowing students to apply AI tools to real-world challenges in interdisciplinary teams. These projects mimic the collaborative nature of the professional data science environment, where data scientists, engineers, and business professionals work together to solve complex problems. Students are often tasked with analyzing big data from various industries, such as healthcare, finance, or retail, and applying ML techniques to develop innovative solutions. For example, a team might work on a healthcare project, using AI to predict patient outcomes based on electronic health records, or a finance project, forecasting stock market trends using historical data. These projects help students develop crucial skills in teamwork, communication, and problem-solving, as they learn to collaborate with individuals from diverse technical and professional backgrounds. Students are also exposed to the process of stakeholder engagement, ensuring that the solutions they develop align with business needs and strategic goals. Additionally, students gain hands-on experience in project management, including task delegation, progress tracking, milestone setting, and presenting results to stakeholders. By working on collaborative projects, students prepare for the multi-disciplinary teamwork required in industry settings, enhancing their ability to tackle real-world data science problems in dynamic, fast-paced environments, which boosts their employability.

4. A case study through Analytic Hierarchy Process

We conduct here a case study via the Analytic Hierarchy Process (AHP), providing resources for college students, majoring in Science and Big Data Technology, to undergo systematic training, learn theoretical knowledge in a structured manner, and acquire practical experience and skills as primary indices. Additionally, we integrate ML modules, offer courses on predictive analytics, incorporate AI model optimization techniques, introduce real-time big data processing techniques, and facilitate collaborative AI and big data projects as secondary indices; see Fig. 1.

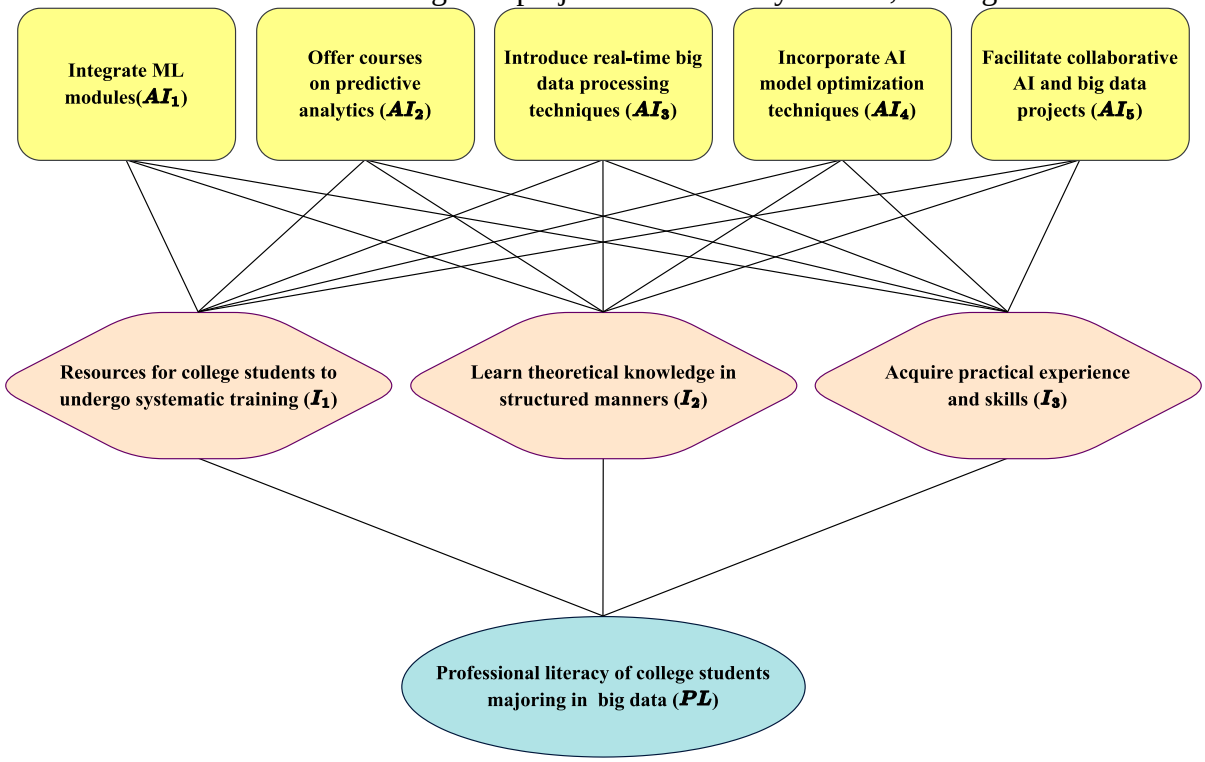

Figure 1: AHP model for college students' professional literacy.

Table 1: Evaluation of the influence of curriculum on professional literacy.

	I_1	I_2	I_3	
I_1	1	$\frac{5}{3}$	3	0.5279
I_2	$\frac{3}{5}$	1	$\frac{5}{7}$	0.2327
I_3	$\frac{1}{3}$	$\frac{7}{5}$	1	0.2394
	0.5279	0.2327	0.2394	

Through expert consultations, questionnaires collected from AI companies as well as government entities, and surveys on the future expectations of college students, we assessed the impact of the curriculum on the professional literacy of Science and Big Data Technology majors (see Table 1). Utilizing the AHP model, we determined the relative priority weights and calculated the corresponding random consistency ratio for the curriculum's contribution to students' professional literacy (see also Table 1). The obtained random consistency ratio, approximately 0.0534, falls below 0.1, indicating the validity of the proposed AHP model.

Similarly, we conducted expert consultations, distributed questionnaires to gather insights from AI companies, industries, and government entities, and surveyed college students to understand their expectations for future careers. These inputs allowed us to evaluate the impact of integrating Artificial Intelligence courses on optimizing the curriculum for Science and Big Data Technology majors. Using the AHP model, we calculated the relative priority weights of various factors influencing curriculum optimization and determined the corresponding random consistency ratios to ensure the reliability of our analysis. Furthermore, by integrating the previously derived priority weights of the curriculum's influence on students' professional literacy (see Table 1), we computed the overall relative priority weights and the overall random consistency ratio, quantifying the contribution of integrating Artificial Intelligence courses to the professional literacy of college students (see Table 2 and Figure 2).

Table 2: Evaluation of the impact of integrating artificial intelligence courses on curriculum optimization and professional literacy.

	AI_1	AI_2	AI_3	AI_4	AI_5	
I_1	0.2823	0.1143	0.1327	0.3455	0.1252	0.0946
I_2	0.1172	0.1178	0.1362	0.3451	0.2848	0.0929
I_3	0.1092	0.1235	0.1273	0.3636	0.2764	0.0943
PL	0.1151	0.1198	0.1317	0.3531	0.2803	

To validate our model, we compute the overall random consistency ratio, to get

$$CR = 0.5279 \times 0.0946 + 0.2327 \times 0.0929 + 0.2394 \times 0.0943 < 0.1$$

which indicates that our AHP evaluation method is highly suitable for this analysis. The quantitative findings highlight that incorporating AI model optimization techniques has the greatest impact on the professional literacy of college students majoring in Data Science and Big Data Technology, as it enhances their ability to develop efficient, scalable, and high-performing AI solutions. The next most influential factor is facilitating collaborative AI and big data projects, which provide students with hands-on experience in solving real-world industry challenges. Additionally, the effects of introducing real-time big data processing techniques, offering courses on predictive analytics, and integrating ML modules are nearly equivalent in their impact on students' professional literacy. Based on these insights, we have implemented targeted curriculum optimization measures, including industry partnerships and updated course structures, for the Data Science and Big Data Technology major at Suqian University, our affiliated institution.

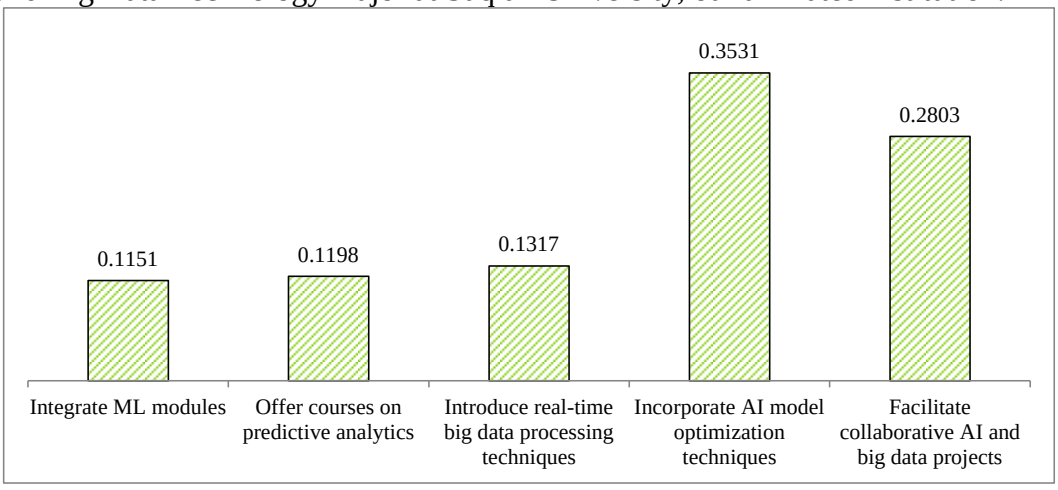

Figure 2: Evaluation of AI on professional literacy.

5. Conclusions

This paper explores and evaluates strategies for improving the curriculum of Data Science and Big Data Technology by incorporating AI courses, with the goal of enhancing the professional literacy of college students. We highlighted the crucial role the curriculum plays in developing the skills and expertise of students majoring in these fields. Several strategies for optimizing the curriculum through the integration of AI courses were proposed, focusing on aligning theoretical knowledge with practical applications. To assess the effectiveness of these strategies, we conducted an empirical study informed by the experiences of our teaching team. The results presented in this paper offer valuable insights and practical guidance for colleges and universities seeking to integrate AI courses into their curricula across a range of disciplines, ultimately strengthening students' readiness for the rapidly evolving job market.

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