

Big Data Analytics and Auditing: Deep Learning Applications and Challenges

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Abstract

This study examines the impact of deep learning and big data analytics in the audit industry, particularly within the context of Industry 4.0. Focusing on the integration of artificial intelligence (AI) and machine learning in audit processes. The research analyses 151 peer-reviewed publications from Scopus through bibliometric and network analysis. The methodology includes data extraction and analysis using Microsoft Excel and VOS viewer software. Key findings highlight the enhanced efficiency and accuracy brought by technological advancements in complex decision-making and fraud detection, alongside raising critical ethical concerns, notably in bias and privacy within automated systems. The study identifies three main thematic clusters: The Data System in Auditing Techniques, Revolutionize of Audits, and Automated Ethical Decision-making in Audits. It concludes that while AI and deep learning offer significant benefits in audit processes, they necessitate a careful balance between efficiency and ethical considerations, urging a reevaluation of ethical frameworks and auditing standards. This research contributes to the understanding of AI-enabled audit practices and outlines future directions for adapting audit practices to technological advancements.

Keywords: Deep Learning, Big Data Analytics, Artificial Intelligence, Auditing

Introduction

The advanced and fast-paced industry has remodeled the auditing industry's operating style and application of work methods. As for Chartered Professional Accountants and Certified Public Accountants performing audit and assurance services looking to keep pace with the rapid adoption and advancement of technologies in our developing data-driven world, the changes are likely being keenly felt. For many auditors, deep learning application and big data analytic is the first step in the digital journey toward AI-enabled audit. This emphasis on technology has come from professional bodies and practitioner. For example, the Association to Advance Collegiate Schools of Business (AACSB) International disclosed Standard A5. The standard applies a comprehensive approach to integrating data analytic into accounting program. Particularly accounting program that acquired to fixate on adaptability and agility because they need to catch up with the changes and disruption in technology (Tapis & Priya, 2019).

Deep learning consists of algorithms that allow software to self-train for tasks such as photo recognition and Natural Language Processing (NLP). Meanwhile, big data analytics is a process used to extract meaningful insights, such as it can be used to prevent audit fraudulent action in the audit. The application of these advanced technologies can be used to conduct analysis of big data, which helps to enhance the efficiency in the accounting job. However,

technological advancement also threatens employees and presents difficulties in audit areas relating to ethics and fraud. Fraud can be discovered in all walks of life, and identifying and preventing fraud represents an important research question relevant to many societal stakeholders (Bao, Hilary & Ke, 2022). This study shows overview of the difficulties in detecting fraud by using machine learning and making ethical audit decisions.

This study aims to provide a thorough understanding of the Industry Revolution 4.0 progression in the audit field of knowledge as well as the limitations of artificial intelligence. This study contributes to the existing literature in several ways. First, it identifies the technologies under audit in a consistent way. Second, the bibliometric analysis gives a thorough overview of previous and current research trends, as well as a trustworthy understanding of this area of intellectual structure. Third, examine the findings of the literature.

Literature review

The auditing profession, historically reliant on traditional methods, has witnessed a paradigm shift with the advent of Industry 4.0. This shift, characterized by the integration of deep learning and big data analytics, is reshaping the landscape of audit and assurance services (Tapis & Priya, 2019). Deep learning, a subset of AI, is revolutionizing audit processes through its capabilities in pattern recognition and natural language processing (Bao, Hilary & Ke, 2022). These advancements have enabled auditors to process vast volumes of data with enhanced efficiency and accuracy.

The application of big data analytics in auditing has been instrumental in fraud detection and prevention. By analyzing large datasets, auditors can identify anomalies and patterns indicative of fraudulent activities (Rosnidah et al., 2022). This not only improves the reliability of audit outcomes but also contributes significantly to the governance and regulatory aspects of financial reporting.

However, the integration of these technologies in auditing is not without challenges. Ethical considerations, particularly in the context of AI and automation, have emerged as critical concerns. The potential for biased outcomes and privacy breaches necessitates a robust ethical framework to guide the deployment of these technologies in auditing practices (Lehner et al., 2022). Moreover, the complexity of AI algorithms, often referred to as the "black-box" problem, poses challenges in terms of transparency and accountability in audit processes (Zhang, Cho & Vasarhelyi, 2022).

The global landscape of auditing research reflects a concentrated effort in a few countries, with significant contributions from the United States, the United Kingdom, Germany, and Australia. This geographical distribution highlights the nascent stage of this research area in the global scientific arena, with potential for growth and diversification (Agustí & Orta-Pérez, 2022).

The incorporation of deep learning and big data analytics in auditing represents a significant advancement in the field. While it offers numerous benefits in terms of efficiency, accuracy, and fraud detection, it also brings forth ethical and practical challenges that need to be addressed. Future research should focus on developing frameworks for ethical AI use in auditing and exploring the implications of these technologies on the auditing profession globally.

Methodology

The study undertook a meticulous selection of a research title and a thorough analysis of relevant literature. Utilising Scopus, the scope was narrowed down to 151 pertinent articles within the Business, Management, and Accounting domains from 2013 to 2022. Data extraction into a Microsoft Excel spreadsheet facilitated the analysis of abstracts, unveiling the prevalence of research methodologies such as qualitative, quantitative, and mixed methods. Moreover, the study employed VOS viewer for the construction and visualisation of bibliometric networks, enabling the categorisation of findings into three distinct clusters, each representing a different facet of the research topic. This comprehensive methodology, utilising Scopus, Excel, and VOS viewer was instrumental in effectively conducting and concluding the research.

Results and Findings

Bibliography

The bibliography presents a comprehensive analysis of literature in the field of Business, Management, and Accounting from 2013 to 2022. Utilising Scopus, the study identified 151 significant articles from 55 countries, including undefined nations. A geographical analysis revealed that the United States, United Kingdom, Germany, Australia, and France were the leading contributors, together accounting for 82.4% of the documents. The data also highlighted contributions from Southeast Asian countries, notably Malaysia and Indonesia. This distribution suggests that the research area is still developing globally, with a concentrated focus in specific regions.

The temporal trend of publications and citations in this field was evaluated using bibliometric techniques. From 2013 to 2022, there was a notable increase in both publications and citations, indicating a growing interest and recognition in the subject area. In 2022 alone, there were 52 documents published with 1015 citations, demonstrating a significant surge in academic activity compared to previous years. This uptrend underscores the evolving and expanding nature of research within the domain.

In terms of influential works, the most cited articles over this ten-year period were identified, providing insights into the key themes and developments in the field. The top cited article, "Algorithms of Work: The New Contested Terrain of Control" by Kellog, Valentine, and Christin, garnered 304 citations in three years. Other notable works include studies on big data, blockchain technology, and artificial intelligence in auditing and supply chain management. These findings reflect the dynamic and rapidly evolving landscape of Business, Management, and Accounting research, highlighting the areas of highest academic impact and interest.

Research Network Analysis

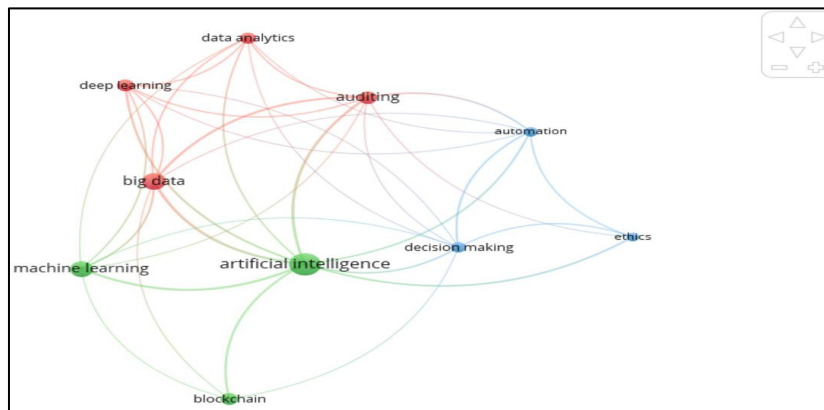


Figure 1: The keyword co-occurrence network map

The research network analysis, conducted using VOS viewer, focuses on three analytical dimensions: keyword co-occurrence, research development over time, and topic trends. The keyword co-occurrence network map (Figure 1) identified ten keywords grouped into three clusters, revealing the predominant themes in deep learning, big data analytics, and auditing. The clusters were categorised as 'The Data System in Auditing Techniques', 'Revolutionise of Audits', and 'Automated Ethical Decision-making in Audits', each representing distinct yet interconnected domains. This analysis underscored the intricate relationships between these topics and their evolving relevance in the field.

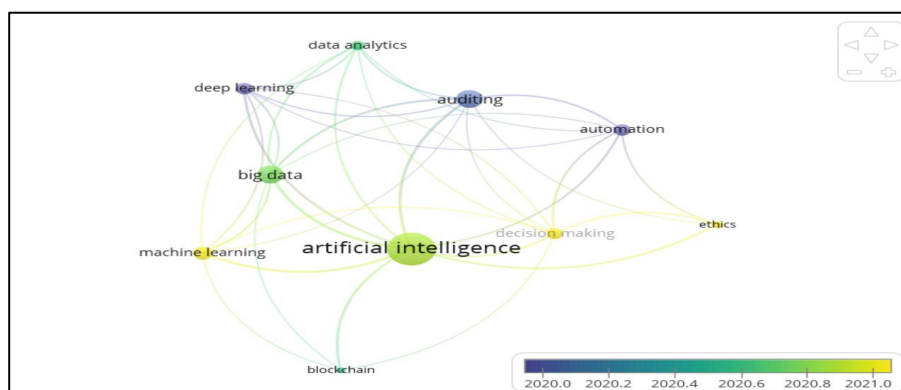


Figure 2: Overlay visualization of research development over (10 years)

In the ten-year research development overlay visualisation (Figure 2), shifts in focus areas over time were highlighted. The progression from earlier themes like deep learning and auditing to more recent ones such as artificial intelligence and machine learning indicates the dynamic nature of the field. The trend analysis suggests an increasing concentration on artificial intelligence, especially its role in audit practices and big data collection.

Cluster 1 - The Data System in Auditing Techniques

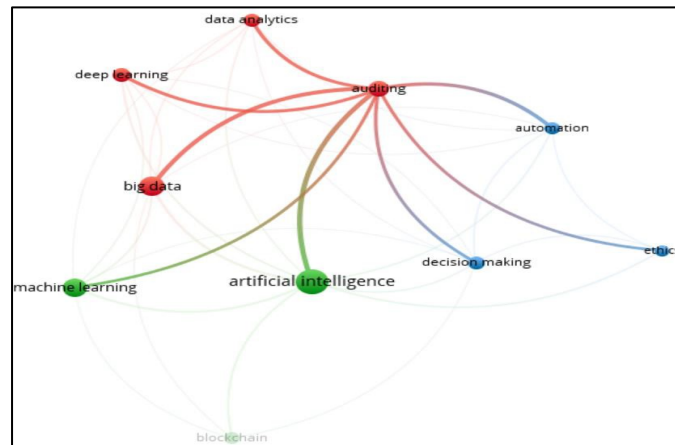


Figure 3: Content analysis for auditing technique

This cluster delves into the integration of deep learning and big data analytics in auditing. The analysis, illustrated in Figure 3, indicates a growing emphasis on how AI systems aid auditors in data processing and interpretation. Studies highlight the significance of cybersecurity in big data systems and the role of AI in enhancing various aspects of auditing, from decision-making to fraud detection. Researchers like Huang, Abrahams and Ratcham (2022) and Biglari and Pourabedin (2022) have contributed to understanding these integrations, emphasising the advancements in data system technologies and their impact on auditing efficiency and ethical considerations.

Cluster 2 - Revolutionise of Audits

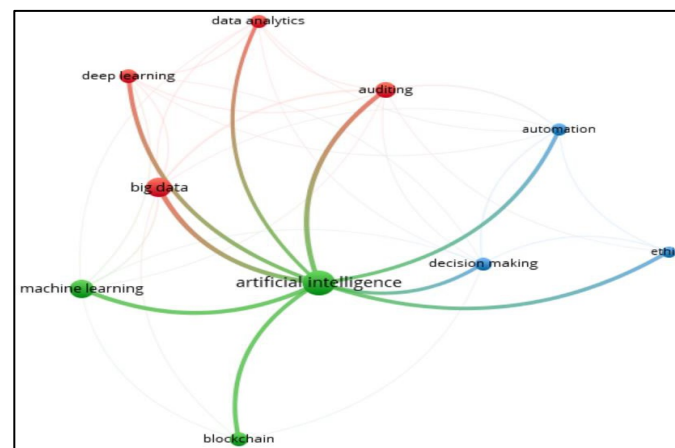


Figure 4: Content analysis for revolution of audits reports

Cluster 2, shown in Figure 4, explores the transformative impact of AI, machine learning, and blockchain in auditing. It addresses the challenges and potential of these technologies, such as the 'black-box' problem in AI and the ethical implications of AI-driven decision-making. The cluster reflects the ongoing revolution in audit practices, with AI and machine learning providing novel ways to analyse data and detect fraud. The works of Holmes and Douglass (2022) illustrate the evolving landscape of audit methodologies, driven by technological advancements and the need for transparency and ethical considerations.

Cluster 3 - Automated Ethical Decision-making in Audit

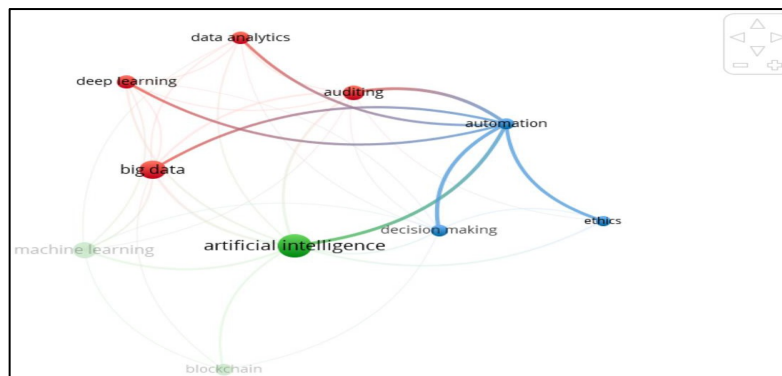


Figure 5: Content analysis for automated ethical decision-making in audit

The focus of Cluster 3, presented in Figure 5, is on the ethical challenges posed by automated decision-making in audits. It examines how automation and AI are reshaping the auditing landscape, with specific attention to ethical implications like bias and privacy concerns. The research suggests that while automation enhances efficiency and insight in audits, it also necessitates a careful consideration of ethical dimensions. The studies by Mökander et al. (2021) and Weiskopf and Hansen (2022) contribute to understanding the ethical frameworks and governance systems needed to navigate the complexities introduced by automation in auditing.

Conclusion

This study provides a comprehensive review of the application of deep learning in big data analytics within the auditing domain, integrating a bibliometric and content analysis approach. The bibliometric analysis, encompassing 672 articles and 151 journals, reveals significant contributions from the United States in the realm of auditing and AI. A key publication in this field is "Algorithms of Work: The New Disputed Terrain of Control" by Kellog, K. C., Valentine, M. A., and Christin, A., with notable contributions from Mikol Antal Vasarhelyi at Rutgers University-Newark Campus.

The content analysis indicates substantial advancements in the auditing profession, particularly in deep learning applications in AI. Deep learning, characterised by its ability to discern complex patterns in large datasets, is emerging as a valuable tool in augmenting audit evidence and enhancing decision-making effectiveness. Auditors are increasingly required to be proficient with technological tools and skills to effectively utilise unstructured and structured data in financial analysis. This study highlights the need for auditors to adhere to ethical considerations, such as data protection, privacy, and technology governance, especially in the context of Automated Decision-Making Systems (ADMS).

The study concludes by underscoring the importance of ethics-based auditing as a governance approach to address the ethical challenges posed by ADMS. It recommends further research to explore, evaluate, and investigate the body of literature in accounting relative to Industry 4.0 technologies, setting a roadmap for future scholarly contributions in auditing and emerging technologies.

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