THE CHALLENGES OF INTEGRATING BIG DATA WITH AI: A COMPREHENSIVE REVIEW

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Abstract
A transformational force across sectors, the integration of big data and artificial intelligence (AI) holds the potential to yield invaluable insights and enhance decision-making capabilities.The proliferation of IoT, cloud computing, and 5G technologies has led to a rapid expansion in the volume of data generated by manufacturing operations. The utilization of extensive industrial data has facilitated significant progress in the domains of product design, manufacturing, and maintenance, surpassing initial anticipations. The advent of big data analytics (BDA) has played a pivotal role in enabling the development of intelligent industrial systems. Nevertheless, this combination is followed by a plethora of complex issues that necessitate careful thought. The main issues surrounding the combination of big data with artificial intelligence are explored in this abstract, including issues with data quality, scaling privacy, fairness, comprehension, governance, and many more. This study presents a thorough overview of related subjects like the idea of big data, model-driven, and data-driven approaches to thoroughly report BDA for intelligent manufacturing systems. The paper encompasses an analysis of the BDA architecture, its evolution, significant technological advancements, and the diverse range of applications within the domain of intelligent manufacturing systems. It draws attention to the necessity of multidisciplinary strategies, moral principles, and strategic thinking to successfully address these issues. Future research opportunities and challenges are also underlined. It is hoped that this work will inspire fresh thinking in the pursuit of realizing the goals of the BDA for advanced industrial systems.
Keywords: Artificial Intelligence (AI); Big Data Analysis (BDA); Internet of Things (IoTs); Machine Learning.

Introduction

The vast majority of domains in human endeavor are believed to possess the capacity to generate data, hence presenting novel opportunities for understanding the world. The accessibility of this data exemplifies the potential of Big Data in facilitating informed decision-making and optimizing resource allocation. Among other things, Artificial Intelligence (AI), the Internet of Things (IoT), and Machine Learning can make a significant contribution to this process (Allam, and Dhunny, 2019).

The rapid development of IoT and the widespread usage of wearable technologies and sensors have led to a substantial increase in data volume. A big data era has emerged as a result of the unheard-of rise in data volumes linked to improvements in analytical approaches powered by AI (Vinayakumar et al., 2020). Electronic records are ill-used by applying cognitive analytics for streamlining services in the various industrial application fields where big data has been used. Big data can be produced from a variety of sources, such as public data (Mehta and Pandit, 2018). in many formats, like mobile devices, text or video, and IoT devices. Digital twin technologies of big data are an information asset that generally has such large velocity, volume, and diversity that it necessitates the acquisition of certain analytical methodologies and technology for its translation into a piece of meaningful information to serve the end users (Barricelli et al., 2020)

The role of Information, Communication, and technology (ICT) has received extensive coverage as cities become more digital and it has been demonstrated that technologies have made it possible for municipalities and governments. Better urban governance is made possible by its processing and analysis because it enables decision-makers to create suitable and responsive policies and make well-informed choices. Artificial intelligence is capable of carrying out this analysis (Allam& Newman, 2018).

A computer scientist, John McCarthy, created the term "Artificial Intelligence" defining it as "an Engineering Science of making intellectual machines" (Mathur&Modani, 2016).Additionally, there are scholars who have characterized it as the process of instructing computers to replicate human cognitive processes and, in some cases, their behavioral patterns. The field of computer science also encompasses the study of data-driven systems that facilitate task execution and decision-making, with a specific focus on emulating human cognitive processes.

Artificial intelligence refers to the emulation of human cognitive abilities in machines, enabling them to engage in reasoning and knowledge-acquisition processes akin to those exhibited by humans. The creation of systems and technologies capable of carrying out procedures that generally need human intellecttoemphasize this large area of computer science. Problem-solving, judgment, speech recognition, language translation, visual perception, and many more processes can be included in these tasks. With more data and processing as machine learning takes place, it is recognized that the accuracy of findings obtained will grow; thus, big data and real-time data are essential (Allam, and Dhunny, 2019).

As AI is a growing technology, it has numerous useful uses across many industries such as telehealth in the healthcare industry, autonomous vehicles in the motorized industry, cybersecurity systems, medical analysis, accepted language and image processing in computer vision, and AI banking in the financial industry. In the research of LeCun et al., (2015) it has been clear that The concept of artificial intelligence has garnered significant attention since its inception in the early 1950s. However, the widespread popularity of AI experienced a notable surge between 2014 and 2017, primarily due to the utilization of Big Data. This surge is anticipated to lead to a synergistic coupling effect. Machine learning (ML) and deep learning (DL), two of the many fields of AI, are significant techniques. The efficacy of algorithms and systems based on Machine Learning is heavily dependent on the inclusion of representative characteristics. Machine learning, in broad terms, encompasses the capacity to acquire knowledge and discern significant patterns from data. While this is going on, DL can solve complex problems by learning from straightforward representations (Pham et al., 2020).

AI and Big Data technologies are developing quickly, and the aforementioned phenomenon has exerted a substantial influence on various aspects of human evolution, encompassing science, politics, the educational system, and economics. According to Daniel, (2019), the primary objective of big data technology is to efficiently utilize substantial volumes of data, regardless of whether it is processed in real-time or by other means.The definition and impression of "Big Data," however, are always changing. Big Data is viewed in terms of volume, velocity, and variety by Alam et al. (2014). Other reports provide a comprehension ofthe analyticand volume approach used by various individuals and organizations. The dimensions of indexicality, resolution, exhaustivity, resolution, extensionality, scalability, and, relationality were introduced to these traits. Cities are anticipated to benefit greatly from these dimensions, as they offer a variety of benefits (Lim et al., 2018).

The 4 V's, which are commonly employed to delineate the distinctive attributes of big data, are regularly utilized. That is quantity, velocity, veracity, and variety. The fifth V i.e. value or the idea that has recently been introduced, explained that the data could be made profitable.The utilization and analysis of massive and intricate datasets provide significant challenges; as conventional data management solutions are inadequate in addressing the intrinsic characteristics of big data. (Dijcks, 2013).

In order to effectively obtain, retain, disseminate, examine, and oversee extensive datasets, novel and innovative computational technologies are required (Geczy, 2015). The process of big data analytics commonly involves the collection, analysis, and evaluation of extensive datasets. The primary benefits of the revolution in big data are commonly perceived as the ability to extract valuable and actionable info and trends from large datasets (Jagadish et al., 2014). The academic disciplines encompassed in this field include visualization of data, analytics of texts, statistical evaluation, social network analysis, data mining, and machine learning. and signal processing are only a few of the technologies used in big data analytics (Luan et al., 2020).

According to Jordan and Mitchell(2015), machine learning is a subset of AI, and is concerned with the development of computer systems capable of autonomously acquiring knowledge from inputs

and adjusting their behavior accordingly, without the need for unambiguous programming.Machine learning algorithms provide fresh viewpoints, deadlines, and approaches that can be tailored to meet the unique demands and situations of individuals. The utilization of machine learning methodologies has demonstrated the capability to generate precise outcomes and facilitate well-informed decision-making, contingent upon the availability of a substantial quantity of superior input training data(Gobert and Sao Pedro, 2017).

Large-scale collection of data and labeling become more crucial as machine learning becomes more prevalent, especially for cutting-edge neural networks. The machine learning and computer vision fields have historically made contributions to this matter, focusing mostly on data labeling methods like active learning and semi-supervised learning. The data management community has recently been making contributions to many subproblems in data assembling, labeling, and improvement in the era of big data (Roh et al., 2019).

The Interaction between AI and Big Data

Big Data and AI are related in several ways:

i. Large datasets are necessary for AI systems to be trained and for them to perform better. They are better able to learn and make precise predictions or conclusions the more data they have access to. Big Data gives AI systems the fuel they require.

ii. Big Data technologies assist in preprocessing and cleaning data so that AI models may use it. This is important because AI algorithms care about the accuracy and applicability of the data they receive.

iii. Big Data is mined for insights, patterns, and useful information using AI, particularly machine learning and deep learning. In large datasets, AI algorithms can find trends, anomalies, and connections that may be difficult or impossible for people to find.

iv. AI and Big Data can be used in a variety of fields, including healthcare, finance, marketing, and many more.

Inclusively it can be stated that AI and Big Data are complementary technologies that, when used together, offer strong solutions for processing, analyzing, and deriving insights from sizable and complicated information, ultimately resulting in improved decision-making and automation in a variety of industries (Surya, 2015).

Our main goal is to comprehend how new management disciplines with the application of AI and Big Data Analytics, develop from the business function disciplines that are currently being studied. With the use of straightforward manual interpretations and analysis, we were able to pinpoint some of the EMDs, as discussed below.

Medical Care and Healthcare

By combining traditional technology and equipment with AI-integrated solutions, many outmoded towns are aiming to emulate the concept of healthcare in smart cities. Smart health can be categorized as a subset of e-health because it is linked to the smart city's ICT infrastructure. Integrated IoT has greatly helped healthcare systems. A few of the problems hindering the implementation of next-generation healthcare are reliability, bandwidth, and network latency. According to Rathi et al., (2021), a healthcare system built on the IoT and edge computing that is responsive, scalable, low potency, and dependable has been proposed.

To predict the course of the epidemic and calculate the number of infections that have not been reported, Alsayed et al. (2020) used the Susceptible Exposed Infectious Recovered model and machine learning. Shahid et al., (2020) also presented prediction procedures employing LSTM, SVR, and other AI approaches to anticipate instances of confirmed recoveries and deaths in ten main nations impacted by the COVID-19 pandemic.

When it comes to extracting extremely unpredictable patterns from a huge dataset, recent cutting-edge techniques, such as advanced artificial neural network methods, have shown promising results. Recent research has employed AI approaches to predict ESBL-producing microbes, identify rodent reservoirs for potential zoonotic illnesses, and halt the spread of tuberculosis (TB) and chlamydia. It's difficult to foresee how the public will react to epidemics of disease. However, the advancement

of AI tools and the accessibility of Big Data have allowed us to better link population behavior to disease outbreaks (Wong et al., 2019).

Safetyfor cities and the environment

As there is an increased population of smart cities, security concerns could become more common. AI inclusion in smart towns has resulted in the protection of citizens. The authors have introduced a machine learning-based architecture for anticipating events and generating replies before they happen (Baughman et al., 2019). A machine-learning approach to predict crime based on geographic data has been created for a variety of offenses. In the year of 2019, Romero and Salameaproposed convolutional models have been widely employed for the purpose of detecting weapons in video surveillance. They have used a variety of CNN architectures to analyze the effectiveness of the system in identifying firearms.

The quantifiable potential fire risk has been created and calculated by utilizing fuzzy deduction and Big Data analysis methods. And a fresh conceptual structure for intelligent disaster management systems has been put out by Jung et al., (2020).

Irrigation and smart farming

By enhancing farming practices' productivity, efficiency, and sustainability, AI is revolutionizing the agricultural sector. AI technologies are used in irrigation and smart farming to improve overall agricultural operations, monitor crop health, and use less water. Some academics have looked into how to develop intelligent, long-term agricultural systems by fusing AI and digital technology with agriculture. Ciruela-Lorenzo et al., (2020),provided a thorough analysis of the advent of smart digital types of machinery including IoT, AI, Big Data, and machines in agronomy. Researchers discovered IoT/AI technical manner that can assist the creation of SSA podiums after examining the utilization of Internet of Things (IoT) and Artificial Intelligence (AI) technologies that are now in operationin environmentally friendly farming (Alreshidi, 2019).Due to the swift pace and rapid development of WSNs/IoThas demonstrated its viability as a tool for farmingmechanization and decision-making. Additionally, studies on sensor-based AI approaches for smart agriculture have suggested an expert system for assessing the suitability of agricultural land that combines networks of sensors that use artificial intelligence (AI) methods such as artificial neural networks (ANN) and multilayer perceptron (MLP) (Herath et al., 2022).

System for Smart Education

Since applications of artificial intelligence have become increasingly important in a wide range of educational fields, the field of education has attracted a lot of interest recently. Utilizing IT and its artificial intelligence (AI) applications is one of the major advancements in smart education. In the beginning, we concentrated on the development of innovative schools and projects in many nations. The first smart school implementation plan was created in Malaysia and started around 1997 under the smart school initiative. This project involved the setting up of innovative schools as a means to enhance the school system and provide it with the necessary capabilities to effectively address the demands and complexities of the 21st century. (Luan et al., 2020).

In 2006, Singapore unveiled its vision for a "smart country", which included smart education supported by modern technologies including the Internet of Things and artificial intelligence. The idea called for the creation of 8 smart schools with an emphasis on creating varied learning environments. Finland started a keen education effort in 2011 that featured a SysTechmethod for ongoing education. The program aimed to improve education for the 21st century by using user-driven motivating educational solutions. To create and implement a keen interdisciplinary education system that will link all of the nation's educational institutions, Australia worked with IBM in 2012.

A smart education program has also been launched by the South Korean government. To incorporate the most recent IT innovations into the classroom, the United States launched the smart school program in 2014 (Herath et al., 2022).

It has been clear that the use of AI to raise the standard of education has been discussed by certain scholars. For instance, Ahmad et al., (2021) explored the role of Machine Learning in smart education. Salem andNikitaeva, (2019) alsodescribed computing intelligence, AI-based smart

learning frameworks, and knowledge of engineering archetypesto construct a smart system of education.

Smart mobility and transportation

Smart transportation and mobility systems are being revolutionized by AI. It can improve transportation's entire user experience, efficiency, safety, and sustainability.An intelligent transportation system (ITS) is a combination of controlled mechanismsand Information and Communication Technologies (ICTs) that produces enormous data and has a major impact on the coming transportation wave in the contemporary modern city. ML, AI, and DRL approaches are crucial for efficiently tracking and making real-time data estimations,associated with the traffic movement in the urban environment, which is a crucial element of future intelligent systems of transportation (Herath et al., 2022).

In recent years, there has been an increase in the application of AI for mobility-related policymaking and routing. Englund (2020) has employed AI methods such as RF, SVM, and MLP. Various researchers proposed a DRL-based better driving behavior policymaking technique in diverse transportation. To efficiently search for passengers, the researchers have studied how to leverage GPS trajectory data from cabs in a certain area.

Use in manufacturing systems

Big data-driven intelligent manufacturing uses have started to develop, driven by technologies such as IoT and intelligent sensing, cloud-based computing, machine learning, and others. Applications in designing a product, planning, quality optimization, operation and maintenance of equipment, and other fields have been approvedto strengthen intelligent industrial systems. It has been implemented in a variety of industrial areas to increase productivity, innovation, and decision-making.As big data technology advances, product design is moving beyond subjective conceptual design and toward data-driven design. Big data-driven product design examines consumer feedback to determine market demand. Then, using data on sales, customers, and manufacturing, it develops a design plan and improves decision-making skills based on historical knowledge (Qi et al., 2016).

The utilization of analytics for big data can provide comprehensive information support for making scheduled decisions based on the obtained data. Based on data from product manufacturing processes and quality inspections, big data-driven quality assurance management achieves product transparency and efficiency. Correlation analysis can be used to determine the primary factors that have the greatest impact on product quality, including raw material characteristics, variables of equipment status, workshop and process variables, and ambient parameters (Gao et al., 2020). BDA models for product quality are built to find the connection between the raw gathered product quality and data in the ability to adapt optimization and regulation of production quality (Wang et al., 2022).

Research challenges in the future

Despite playing a very important role in the world today, artificial intelligence and big data studies will face a lot of serious challenges in the future because these topics are continually evolving. These problems must be resolved to fully realize the potential of AI and big data as well as to ensure their appropriate and ethical deployment. Some of the challenges are listed below:

- Despite exhibiting exceptional competence in generating human-like writing, there are instances where it produces information that is either inaccurate or misleading. The preservation of scientific research's legitimacy is contingent upon the caliber and reliability of AI-generated information.
- Artificial intelligence (AI) has the capability to generate text of superior quality; but, it is also prone to generating responses that are unsuitable or of substandard quality. Continuous tracking, training, and development are essential in ensuring that the database consistently generates text of high quality.
- AI models are so huge and intricate, they consume a lot of energy and may harm the environment. The improvement of models' energy efficiency is a significant issue that requires attention.

- AI access to such a large amount of user data, confidentiality, and security issues are raised. To guarantee that user data is protected and utilized responsibly, it is crucial to adopt policies and regulations.
- Text generated by AI models of language like ChatGPT might not always be accurate or trustworthy. A significant problem is confirming that the generated material is factually accurate and consistent, especially in applications where precise data is crucial, like news, education, or healthcare (Ray, 2023).

Conclusion

As intelligent manufacturing systems receive more attention, AI and BD are emerging as key techniques to support prediction and selection procedures inside systems for production.Big Data Analytics (BDA) enhances the value of diverse products and systems through the integration of state-of-the-art technologies into traditional manufacturing procedures. The future outlook holds great significance in both contexts, scientific and industry communities. Scholars have the capacity to ethically harness the capabilities of artificial intelligence (AI) in order to enhance human comprehension and knowledge, while simultaneously addressing the challenges and ethical concerns associated with its utilization. The question of whether we can attempt to handle the difficult topic of how to use recent advancements in collaborative platforms to improve data consumption for specified domains in the future is raised by evaluating numerous studies. Numerous issues with data exist, such as how to control, manage, and modify different sources of information relating to diverse topics and the current advancement of data management systems. The many data sources determine the best strategy to combine cutting-edge data mining, simulation, and monitoring tools to optimize the recognition of appearing and reappearing problems. It takes a thorough and interdisciplinary approach to address these issues. By surmounting these challenges, intelligence models will exhibit enhanced performance and heightened utility, and deliver an improved user experience, hence augmenting their efficacy across diverse applications and areas. To effectively incorporate big data and AI into their operations, organizations have to make investments in cultural changes as well as in technical solutions. For maintaining fairness, transparency, and regulatory compliance, adherence to moral and accountable AI methods is also crucial. This article has discussed the main ideas, technological models, and applications of both AI and BD. A systematic review is followed by the highlighting of unresolved concerns for additional study.

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