Abrar Ullah · Sajid Anwar · Davide Calandra ·
Raffaele Di Fuccio
Editors

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Editors
Abrar Ullah
School of Mathematical and Computer Science
Heriot-Watt University
Dubai, United Arab Emirates

Sajid Anwar
Center of Excellence in Information Technology, Institute of Management Sciences (IMSciences)
Peshawar, Pakistan

Davide Calandra
University of Turin
Turin, Italy

Raffaele Di Fuccio
University of Foggia
Foggia, Italy

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Preface

This conference addresses the importance that IT professionals, academics and researchers stretch across narrowly defined subject areas and constantly acquire a global technical and social perspective. ICITA 2023 offers such an opportunity to facilitate cross-disciplinary and social gatherings. Due to breadth and depth of the topics, it is challenging to class them into specific categories, however, for the convenience of readers, the conference covers a wide range of topics which are broadly split into software engineering (SE), machine learning, network security and digital media and education.

The need for novel SE tools and techniques which are highly reliable and greatly robust is order of the day. There is a greater understanding that design and evolution of the software systems and tools must be "smart" if it is to remain efficient and effective. The nature of artifacts, from specifications through to delivery, produced during construction of software systems can be very convoluted and difficult to manage. A software engineer cannot find all its intricacies by examining these artifacts manually. Automated tools and techniques are required to reflect over business knowledge to identify what is missing or could be effectively changed while producing and evolving these artifacts. There is an agreed belief among researchers that SE provides an ideal platform to apply and test the recent advances in artificial intelligence (AI) tools and techniques. More and more SE problems are now resolved through the application of AI, such as through tool automation and machine learning algorithms.

Machine learning is a broad subfield of computational intelligence that is concerned with the development of techniques that allow computers to "learn". With an increased and effective use of machine learning techniques, there has been rising demand for the use of this approach in different fields of life. There is a wider application of machine learning in different domains of computer science including ecommerce, software engineering, robotics, digital media and education and computer security. Given the opportunities and challenges of the emerging machine learning applications, this area has a great research potential for further investigation.

The growth of data has revolutionized the production of knowledge within and beyond science, by creating efficient ways to plan, conduct, disseminate and assess high-quality novel research. The past decade has witnessed the creation of innovative

approaches to produce, store and analyze data, culminating in the emergence of the field of data science, which brings together computational, algorithmic, statistical and mathematical techniques toward extrapolating knowledge from ever-growing data sources. This area of research is continuously growing and attracts a lot of interest.

Computer security is a process of protecting computer software, hardware and networks against harm. The application of computer security has a wider scope, including hardware, software and network security. In the wake of rising security threats, it is eminent to improve security postures. This is an ongoing and active research area which attracts a lot of interests from researchers and practitioners.

With the advent of the Internet and technology, the traditional teaching and learning has largely transformed into digital education. Teachers and students are significantly reliant upon the use of digital media in face-to-face classrooms and remote online learning. The adoption of digital media in education profoundly modifies the landscape of education, particularly with regard to online learning, e-learning, blended learning and face-to-face digital-assisted learning, offering new possibilities but also challenges that need to be explored and assessed.

The International Conference on Information Technology and Applications (ICITA) is an initiative to consider the above-mentioned considerations and challenges. Besides the above topics, International Workshop on Information and Knowledge in the Internet of Things (IKIT) 2023 was run in conjunction with ICITA 2023 with a focus on Internet of Things (IoT).

ICITA 2023 was able to attract 117 submissions from 21 different countries across the world. From the 117 submissions, we accepted 52 submissions, which represents an acceptance rate of 44%. Out of 52, IKIT 2023 received 17 submissions with 7 accepted papers. Out of all submissions, 52 were selected to be published in this volume. Each submission is reviewed by at least two to three reviewers, who are considered experts in the related submitted paper. The evaluation criteria include several issues, such as correctness, originality, technical strength, significance, quality of presentation, interest and relevance to the conference scope. This volume is published in Lecture Notes in Networks and Systems Series by Springer, which has a high SJR impact.

We would like to thank all Program Committee members as well as the additional reviewers for their effort in reviewing the papers. We hope that the topics covered in ICITA proceedings will help the readers to understand the intricacies involving the methods and tools of software engineering that have become an important element of nearly every branch of computer science.

We would like to extend our special thanks to the keynote speakers, David Tien, Senior Lecturer, Charles Sturt University and Vice Chairman, IEEE Computer Chapter, NSW, Australia and Prof. Álvaro Rocha, Professor, University of Lisbon,

Portugal, President of AISTI (Iberian Association for Information Systems and Technologies) and Chair of IEEE SMC Portugal Section Society Chapter.

Dubai, United Arab Emirates — Abrar Ullah, Ph.D.
Turin, Italy — Davide Calandra, Ph.D.
Foggia, Italy — Raffaele Di Fuccio, Ph.D.
Peshawar, Pakistan — Sajid Anwar, Ph.D.

An Effective Decision-Making Trilogy: Data-Driven, Artificial Intelligence, and Blockchain

Teresa Guarda, Filipe Mota Pinto, and Isabel Lopes

Abstract This paper presents an insightful analysis of the trilogy of data-driven techniques, artificial intelligence (AI), and blockchain technology as a power structure that contributes to an efficient, agile, and secure decision-making process based on the analysis of large datasets is further enhanced by the integration of more receptive AI techniques, enabling pattern recognition, prediction, and automation. Meanwhile, blockchain technology provides a decentralized, transparent, and immutable platform of secure data, facilitates trust, and streamlines data sharing. This paper explores the synergistic potential of combining data-driven approaches, AI, and blockchain to transform decision-making across industries.

Keywords Data driven · Artificial intelligence · Blockchain · Decision-making · Proactivity

1 Introduction

In today's rapidly evolving digital environment, organizations face unprecedented amounts of information from sources such as social media, sensors, and networks. The potential of this data to be harnessed and transformed into actionable insights is important for effective decision making.

T. Guarda (✉)
Universidad Estatal Península de Santa Elena, La Libertad, Ecuador
e-mail: tguarda@gmail.com

T. Guarda · F. Mota Pinto · I. Lopes
Algoritmi Centre, Minho University, Guimarães, Portugal

F. Mota Pinto
Instituto Politécnico de Leiria, Leiria, Portugal

I. Lopes
Applied Management Research Unit (UNIAG), Instituto Politécnico de Bragança (IPB), Bragança, Portugal

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In the current business environment, characterized by strong competition and challenges caused by technological advances, companies, in order to maintain or obtain a competitive advantage, need their information systems to allow them to make on-time informed decisions (Ahmad et al. 2022; Ahmed et al. 2022).

Data-driven decision-making uses data as the basis for making informed choices (Awan et al. 2021). Data-driven decision-making enables organizations to identify hidden opportunities, mitigate risks, optimize processes, and improve overall performance (Baiod et al. 2021; Borges et al. 2021).

By using machine learning algorithms, AI systems can automatically process large amounts of data, recognize patterns, and make accurate predictions by analyzing historical data and identifying correlations. AI can provide insights that valuable in helping decision-makers understand complex relationships and predict future outcomes. Additionally, AI-powered decision support systems can automate routine tasks, providing valuable time for strategic thinking and more nuanced decision-making (Bousdekis et al. 2021).

One of the reasons for the attention and interest that blockchain technology has awakened in the industry is the fact that it conveys confidence in transparency and security in all sectors (Centobelli et al. 2022). Blockchain guarantees the integrity and immutability of data, making it more resistant to manipulation and fraud (Duan et al. 2019). Blockchain in decision-making processes can provide data sharing a security and transparency among stakeholders has been simplified, enabling better collaboration while maintaining data privacy and confidentiality (Khatib et al. 2022). The centralized nature eliminates the need for intermediaries, reduced costs are thus, speeding up transactions (Elgendy and Päivärinta 2022).

We aim to shed light on the combined impact on decision-making processes across sectors. The paper will explore the combination of data-driven approaches and AI, the role of blockchain in securing shared data, and the improved decision-making capabilities achieved through their integration.

I will be explored the interplay between data-driven methods, artificial intelligence, and blockchain; focusing on their combined capabilities. Finally, the sixth section concludes the paper and provides future directions.

2 Data-Driven Decision-Making

Data-driven decision-making in the business environment is a process that involves the collection, processing, and analysis of data for the purpose of making decisions (Galbreath et al. 2023) (Fig. 1; Table 1). Being fundamental for any business environment, but especially in the current context, given its complexity due to its constant changes, increasing uncertainty and complexity, reducing risk, improving efficiency, and enabling innovation. It is therefore essential that companies implement tools and systems that enable them to collect, analyze, and use data effectively (Howard 2019; Galbreath et al. 2023).

Fig. 1 Data-driven decision-making key components

Data-driven decision-making offers organizations many benefits: improved precision; better insights; increased speed of decision-making; proactive problem solving; and optimize resources (Mandinach and Jackson 2012; Nudurupati et al. 2022; Rahmaty 2023) (Table 2).

2.1 Artificial Intelligence in Decision-Making

Artificial intelligence plays a key role in enhancing the decision-making process by analyzing large amounts of data with advanced algorithms and computing power (Raj et al. 2020).

Artificial intelligence refers to the simulation of human intelligence in machines that typically explore human intelligence, such as perception, reasoning, learning, and decision-making (Russell 2019). AI technology enables computers and systems to analyze complex data, recognize patterns, make predictions, and it is a functional task to improve organizations decision-making process (Sarker 2021).

AI can help decision-makers by providing valuable insights, automating routine tasks, and supporting robust decision-making processes. By processing and analyzing massive amounts of data, AI can identify trends, relationships, and anomalies that humans might miss, leading to more accurate and informed decisions (Sarker 2022).

Machine learning, a subset of AI, enables systems to learn from experience and improve without explicit programming. It uses algorithms to analyze data, identify patterns, and make predictions or classifications. Historical data can be used to train

Table 1 Phases of data-driven decision-making (Howard 2019; Lim et al. 2021)

Phase	Description
Data collection|	Organizations collect data from a variety of sources, including customer behavior, social media, sensors, analytics, and internal databases. The information gathered should be relevant to the decision-making process and relevant to the goals and needs of the organization. It is important to ensure that the data is accurate, complete, and up-to-date. Methods of data collection can include manual data entry, automated data feeding, data pulling, and external data synthesis (Mandinach and Jackson 2012). Organizations need to establish strong data governance practices to improve data quality and ensure compliance with privacy laws and ethical guidelines
Data processing	Data processing involves many steps such as data cleaning, integration, transformation, and aggregation. Data correction addresses inconsistencies, errors, and missing values, and ensures data integrity. Data integration combines data from multiple sources, providing a comprehensive view of the information. Data transformation is the conversion of data into a standardized format for easy analysis. The aggregate summarizes the data upward for better understanding and decision-making process Advanced technologies such as data pipelines, extract, transform, and load (ETL) systems, and data integration tools can simplify the data processing phase, reduce manual effort, and improve efficiency (Nudurupati et al. 2022)
Data analysis	Data analysis is an important step in data-driven decision-making. It uses a variety of analytical techniques to uncover patterns, trends, relationships, and insights from the data collected and processed (Baiod et al. 2021). A variety of data analysis methods can be used, including descriptive analysis, predictive analysis, and descriptive analysis The descriptive analysis provides a summary and visualization of historical data, enabling organizations to understand past trends and patterns (Borges et al. 2021). Predictive analytics uses mathematical models and machine learning algorithms to make predictions about future results based on historical data (Rahmaty 2023). Mandatory assessments go one step further by recommending the best course of action to achieve a specific goal or improve performance

machine learning models, enabling accurate predictions of future results (Scully and Höbig 2019).

AI techniques such as natural language processing, data mining, and optimization algorithms to analyze data provide insights and identify possible ways to make DSS help decision-makers.

The integration of AI in decision-making allows for greater accuracy, pattern recognition, real-time decision-making, and automation of routine tasks, improving the decision-making process (Table 3).

Table 2 Data-driven decision-making benefits

Benefit	Description
Improved precision	Data-driven methods provide a more objective and evidence-based basis for decision-making, reducing reliance on intuition or gut feelings
Better insights	Data analytics enable organizations to uncover hidden patterns, trends, and relationships that may not be apparent through traditional decision-making methods. These insights can provide a competitive advantage and support strategic management use in a proper manner
Increased speed of decision-making	Data-driven decision-making enables real-time or near-real-time analytics, allowing organizations to react quickly to changing circumstances and make decisions on the fly in the right
Proactive problem solving	Data-driven approaches can help identify potential issues or risks before they escalate, enabling organizations to take proactive measures and minimize potential negative impacts on the results
Optimize resources	Data analytics enable organizations to identify inefficiencies and optimize distribution, reducing costs, and improving operational efficiency

Table 3 Integration of AI into decision-making benefits

Benefit	Description
Improved precision and accuracy	AI algorithms can analyze large amounts of data with speed and accuracy, providing decision-makers with accurate and reliable information to make in-formed choices
Advanced insights and pattern recognition	AI systems can identify complex patterns, relationships, and trends in data, helping decision-makers understand complex relationships and identify hidden opportunities or risks
Real-time decision-making	AI technology enables real-time analysis of data, enabling decision-makers to react quickly to changing circumstances and make decisions based on up-to-date information
Automation of routine tasks	AI can automate routine tasks, saving time, and resources. This enables decision-makers to focus on higher order thinking and robust decision-making
Enhancing human decision-making	AI acts as a powerful tool for decision-makers, providing them with insights, suggestions, and ideas to support their decision-making processes and support human judgment and knowledge, enabling them to make more advanced decisions, and it has good knowledge

3 Blockchain for Secure and Transparent Decision-Making

Blockchain technology has emerged as a powerful tool to ensure a secure and transparent at decision-making process. This section provides a detailed overview of blockchain's key components and its role in decision-making process.

Blockchain technology provides transparency and accountability, which are important elements in the decision-making process. Every transaction recorded on the

blockchain is transparent and visible to all stakeholders, creating accountability and reducing the risk of manipulation or corruption. This transparency enables decision-makers to access reliable and verifiable information, facilitating these informed and reliable decisions.

Additionally, the immutable nature of the blockchain ensures that once a transaction is recorded, it cannot be changed or deleted without consent from the network. This feature provides an auditable trajectory of all transactions, providing decision-makers ability to examine the history and authenticity of data, and increase transparency and accountability.

Smart contracts are self-executing contracts, with the terms and conditions written directly in alphabetical order on the blockchain. These contracts automate predetermined actions to meet specified conditions. Smart contracts enable automated decision-making, as they eliminate the need for intermediaries and facilitate trust between parties involved in a transaction or agreement.

Smart contracts can be used to streamline decision-making processes by automating tasks, validating scenarios, and executing tasks based on preset rules This automation saves time and reduces costs not only reduces the chances of errors and conflicts.

Blockchain technology finds applications in a variety of decisions, including supply chain management, finance, healthcare, and governance. Some notable applications include: supply chain management; financial transactions; healthcare data management; and governance and electoral systems (see Table 4).

Table 4 Blockchain technology applications

Applications	Description
Supply chain management	Blockchain can track the flow of goods and ensure authenticity and integrity throughout the supply chain. Decision-makers can make informed product choices based on reliable real-time information about product origin, quality, and management
Financial transactions	Blockchain-based cryptocurrencies and digital tokens provide secure and transparent financial transactions without the need for intermediaries. Decision-makers can use blockchain to facilitate cross-border payments, reduce transaction costs, and increase financial inclusion
Healthcare data management	Blockchain can securely store and share patient health records, ensuring confidentiality and interoperability. Healthcare decision-makers can access accurate and up-to-date patient data, leading to better informed decisions and improved patient outcomes
Governance and electoral systems	Blockchain can facilitate a secure and transparent electoral process, enabling decentralized decision-making processes. Decision-makers can enhance trust and participation by ensuring that voting and voting processes are fair and equitable

4 Synergy of the Trilogy

Combining data-driven decision-making with artificial intelligence can improve data quality and analysis. AI algorithms can collect, process, and analyze data, providing decision-makers with relevant and timely insights. By using blockchain technology, decision-makers can increase trust and transparency by ensuring the security and authenticity of data.

Furthermore, the combination of AI and blockchain can enable more sophisticated analytics, such as predictive analytics, anomaly detection, and pattern recognition, and these insights can quickly inform data-driven decision-making, and for what results have improved.

The combination of AI and blockchain can automate decision-making processes using smart contracts and consensus mechanisms. Smart contracts can be predetermined actions based on predetermined conditions, requiring mediation, and building trust between parties.

Additionally, using blockchain and AI can enable secure and transparent data sharing between multiple parties. This can facilitate more informed and collaborative decision-making, improving outcomes.

The integration of data-driven decision-making, artificial intelligence, and blockchain technology faces challenges, highlighting the technical challenges to integrating these three technologies which requires technical expertise and can be costly and materially significant.

5 Conclusions

Data-driven decision-making allows decision-makers to gain valuable insights from large amounts of data, enabling them to understand complex relationships and make evidence-based choices.

Artificial intelligence for decision-making processes improves by automating services, delivering accurate forecasts and supporting robust analytics.

Blockchain technology ensures security, transparency, and accountability in decision-making through decentralized consensus mechanisms and immutable records. It enhances data integrity, protects against tampering, and provides measurable paths for interactions.

The network of the triad offers many advantages, including improved accuracy, enhanced insights, real-time decision-making, automation, and better distributed resources but challenges such as data must be overcome pa, privacy concerns, and technical challenges to ensure effective implementation.

As technology advances and researchers move deeper into these areas, future directions will focus on optimizing algorithms, integrating emerging technologies, addressing privacy concerns, developing standards working together, and by ensuring ethical and responsible use.

In conclusion, the successful integration of data-driven decision-making, artificial intelligence, and blockchain technology has the potential to revolutionize decision-making processes across industries, offering exciting prospects with promise a variety of possibilities that will shape future decision-making more efficient, transparent, and secure resulting and field.

Addressing privacy concerns is crucial for data-driven decision-making, AI, and in the widespread use of blockchain. Future research should focus on developing privacy strategies that allow secure and anonymous data sharing while maintaining data integrity and confidentiality.

Efforts should be made to establish communication standards and policies to fully realize the potential of the triad.

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