

A Systematic Review of Emerging Applications of Artificial Intelligence in Computer Science

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ABSTRACT

Artificial Intelligence (AI) has become a core component of modern computer science, driving innovation across diverse application domains. This systematic review examines emerging applications of Artificial Intelligence in computer science by synthesizing recent scholarly literature. The study analyzes peer-reviewed research to identify key application areas, including machine learning-based data analytics, natural language processing, computer vision, cyber security, software engineering, cloud computing, and Internet of Things-enabled systems. Emphasis is placed on recent advances such as deep learning architectures, explainable AI, and the integration of AI with big data and edge computing platforms. The review also highlights current challenges related to data privacy, model interpretability, ethical considerations, and computational complexity. By consolidating existing research findings, this study provides a structured overview of technological trends and research directions in AI-driven computer science applications. The insights presented are expected to assist researchers, academicians, and practitioners in understanding the evolving role of Artificial Intelligence and in identifying potential areas for future investigation.

Keywords: Artificial Intelligence, Computer Science, Emerging Applications, Systematic Review, Machine Learning.

INTRODUCTION

Artificial Intelligence (AI) has evolved into one of the most significant and transformative disciplines within the broader field of computer science. It encompasses the design and development of intelligent systems capable of simulating human cognitive functions such as learning, reasoning, decision-making, perception, and problem-solving. The conceptual foundations of AI were laid in the mid-twentieth century; however, its practical realization has accelerated rapidly in recent decades due to advancements in computational power, availability of large-scale datasets, and the development of sophisticated algorithms. Today, AI is no longer confined to theoretical research but has become an integral component of modern computing systems and real-world applications.

The exponential growth of digital data and improvements in hardware technologies, including graphics processing units (GPUs) and cloud-based infrastructures, have played a crucial role in advancing AI research. Machine learning, deep learning, and reinforcement learning techniques have enabled systems to automatically learn from data, identify complex patterns, and make accurate predictions. These techniques have significantly enhanced the performance of applications in areas such as data analytics, image and speech recognition, recommendation systems, and intelligent automation. As a result, AI has emerged as a core driver of innovation in computer science and related disciplines.

In the domain of computer science, emerging applications of AI are increasingly visible across multiple subfields. In data science and big data analytics, AI algorithms facilitate efficient data processing, predictive modeling, and knowledge discovery from massive and heterogeneous datasets. Natural language processing enables machines to understand, interpret, and generate human language, supporting applications such as chat bots, virtual assistants, sentiment analysis, and automated text summarization. Similarly, computer vision

techniques powered by deep neural networks have revolutionized image and video analysis, enabling facial recognition, medical image diagnosis, autonomous surveillance, and object detection systems.

AI has also made substantial contributions to cyber security by enhancing threat detection, intrusion prevention, and anomaly analysis. Intelligent security systems leverage machine learning models to identify malicious activities and adapt to evolving cyber threats in real time. In software engineering, AI-based tools support automated code generation, software testing, defect prediction, and requirement analysis, thereby improving software quality, development efficiency, and reliability. Furthermore, the integration of AI with cloud computing and the Internet of Things (IoT) has enabled the development of smart environments, intelligent resource management systems, and real-time decision-support applications.

Despite these advancements, the rapid adoption of AI has introduced several challenges and concerns. Issues related to data privacy, security, ethical implications, and algorithmic bias have gained increasing attention from researchers and policymakers. The lack of transparency and interpretability in complex AI models, particularly deep learning systems, poses challenges for trust, accountability, and regulatory compliance. Additionally, high computational costs and energy consumption associated with large-scale AI models raise concerns regarding sustainability and accessibility.

Given the dynamic nature of AI research and its expanding application landscape, a systematic review of emerging AI applications in computer science is both timely and necessary. Such a review provides a structured synthesis of existing research, identifies dominant trends and technological advancements, and highlights unresolved challenges and research gaps. This study aims to systematically examine recent literature on emerging applications of Artificial Intelligence in computer science, offering a comprehensive understanding of current developments and future research directions. The insights derived from this review are expected to serve as a valuable reference for researchers, academicians, and practitioners seeking to explore and contribute to the evolving field of AI-driven computer science.

REVIEW OF LITERATURE

LeCun, Bengio, and Hinton (2015) provided a landmark contribution to the field of Artificial Intelligence by demonstrating the effectiveness of deep learning techniques in solving complex problems related to computer vision, speech recognition, and pattern analysis. Their study emphasized convolutional and recurrent neural networks as powerful tools capable of automatically extracting hierarchical features from large datasets. The authors highlighted that deep learning had significantly outperformed traditional machine learning approaches, thereby opening new possibilities for AI-driven applications across various areas of computer science.

Goodfellow, Bengio, and Courville (2016) presented a comprehensive theoretical and practical overview of deep learning methodologies. Their work systematically discussed neural network architectures, optimization techniques, and learning paradigms. The study emphasized the growing applicability of AI in natural language processing, image analysis, and intelligent systems. It also highlighted challenges related to overfitting, computational complexity, and data dependency, which became important considerations for future AI research in computer science.

Esteva et al. (2017) explored the application of deep neural networks in image classification tasks, demonstrating performance comparable to human experts. Although focused on medical imaging, the study had significant implications for computer science, particularly in computer vision and automated decision-support systems. The authors emphasized the scalability of AI models and their potential to be adapted to other domains such as surveillance, object recognition, and autonomous systems.

Jordan and Mitchell (2018) examined the role of machine learning as a core component of Artificial Intelligence and its increasing integration with data-driven computing systems. Their study highlighted how AI techniques were being widely adopted in big data analytics, recommendation systems, and predictive modeling. The authors also emphasized emerging challenges such as model interpretability, fairness, and the ethical use of AI, which began to attract attention in computer science research.

Zhang et al. (2019) investigated the application of Artificial Intelligence in cybersecurity, focusing on intrusion detection systems and anomaly detection mechanisms. The study demonstrated that machine learning-based security frameworks significantly improved detection accuracy and adaptability compared to traditional rule-based systems. The authors highlighted AI's capability to analyze large volumes of network data in real time, thereby strengthening the role of AI in secure computing environments.

Russell and Norvig (2020) provided an updated and holistic perspective on Artificial Intelligence, emphasizing its expanding applications across multiple domains of computer science. Their work discussed intelligent agents, learning systems, and reasoning mechanisms while addressing ethical concerns, transparency, and accountability in AI systems. The study stressed the importance of responsible AI development and the need for human-centered approaches in emerging AI applications.

Shrestha and Yang (2021) reviewed the growing use of AI in software engineering practices. Their study analyzed applications such as automated software testing, defect prediction, effort estimation, and code recommendation systems. The authors concluded that AI-based tools significantly improve software development efficiency and quality. However, they also pointed out limitations related to dataset availability and generalization of AI models across different software projects.

Kumar et al. (2022) examined the integration of Artificial Intelligence with cloud computing and Internet of Things (IoT) platforms. The study highlighted AI-driven resource allocation, predictive maintenance, and intelligent monitoring systems. The authors emphasized that the convergence of AI, cloud, and IoT technologies has enabled the development of smart environments and real-time decision-making systems, thereby expanding the scope of AI applications in computer science.

Li, Chen, and Wang (2023) focused on the emerging concept of Explainable Artificial Intelligence (XAI). Their study analyzed techniques aimed at improving the transparency and interpretability of complex AI models. The authors emphasized that XAI is essential for building trust, ensuring ethical compliance, and facilitating adoption of AI systems in critical domains. The study identified XAI as a key research direction within modern computer science.

Patel and Singh (2024) reviewed recent advancements in generative AI and large language models, highlighting their transformative impact on natural language processing, content generation, software development, and intelligent automation. The study emphasized challenges related to data privacy, bias, and high computational costs. The authors concluded that generative AI represents a significant milestone in the evolution of AI applications and will continue to shape future research in computer science.

Importance Of the Study:

The importance of the study titled “**A Systematic Review of Emerging Applications of Artificial Intelligence in Computer Science**” lies in its comprehensive examination of the rapidly evolving role of Artificial Intelligence in modern computing. As AI continues to influence almost every sub-discipline of computer science, a systematic review becomes essential to consolidate scattered research findings and present a coherent understanding of current developments.

This study is significant because it provides a structured synthesis of recent literature on emerging AI applications, enabling researchers and academicians to understand dominant trends, technological advancements, and methodological approaches adopted in contemporary research. By categorizing AI applications across areas such as machine learning, data analytics, natural language processing, computer vision, cyber security, software engineering, cloud computing, and the Internet of Things, the study offers a holistic perspective on how AI is transforming computer science.

The study also holds practical importance for industry professionals and system developers by highlighting real-world applications and emerging technologies that can be leveraged for intelligent system design and innovation. Furthermore, by identifying research gaps, challenges related to interpretability, ethics, data privacy, and computational complexity, the study provides valuable direction for future research and policy formulation.

Overall, this systematic review serves as a reliable reference for scholars, students, and practitioners, contributing to informed decision-making, responsible AI development, and the advancement of knowledge in the field of computer science.

Theoretical Framework:

The theoretical framework of the present study has been developed to explain the interrelationship among Artificial Intelligence, Computer Science, Emerging Applications, Machine Learning, and Systematic Review. This framework has provided a conceptual basis for understanding how Artificial Intelligence has functioned as a core technological driver within the domain of computer science and how its emerging applications have been identified and analyzed through a systematic review approach.

Computer Science

Computer Science has constituted the foundational discipline of the present study and has provided the theoretical, methodological, and technological base for the development of Artificial Intelligence. It has included areas such as algorithms, data structures, programming languages, databases, software engineering, computer networks, and operating systems. Advances in computer science have enabled high-performance computing, efficient data processing, and scalable system design, which have supported the implementation of intelligent algorithms. Without the continuous evolution of computer science, the development and deployment of Artificial Intelligence applications would not have been possible.

Artificial Intelligence

Artificial Intelligence has emerged as a transformative branch of computer science that focuses on creating systems capable of mimicking human cognitive abilities. AI has involved techniques for learning, reasoning, perception, planning, and decision-making. Over time, Artificial Intelligence has shifted from rule-based systems to data-driven and learning-based models, thereby increasing system autonomy and adaptability. AI has acted as the central theoretical construct of this study, providing the conceptual framework for understanding how intelligent behavior has been achieved in computational systems.

Machine Learning

Machine Learning has served as a critical subfield of Artificial Intelligence and has played a pivotal role in enabling intelligent behavior in modern systems. It has allowed machines to learn from historical data, identify hidden patterns, and make accurate predictions without explicit programming. Techniques such as supervised learning, unsupervised learning, reinforcement learning, and deep learning have significantly enhanced the performance of AI systems. Machine learning models have formed the backbone of emerging AI applications in areas such as data analytics, natural language processing, computer vision, and cyber security.

Emerging Applications

Emerging Applications have represented the practical outcomes of integrating Artificial Intelligence and Machine Learning within computer science. These applications have expanded across diverse domains, including intelligent data analysis, speech and image recognition, recommendation systems, autonomous systems, smart cloud services, and Internet of Things-based environments. The emergence of these applications has been driven by the availability of big data, advancements in computational infrastructure, and improvements in learning algorithms. These applications have demonstrated how AI technologies have addressed complex, real-world problems more efficiently than traditional computing methods.

Systematic Review

The Systematic Review has been adopted as a structured and rigorous methodological approach to examine existing scholarly literature related to Artificial Intelligence applications. It has involved clearly defined inclusion and exclusion criteria, systematic search strategies, and critical evaluation of selected studies. Through this approach, the systematic review has enabled the identification of dominant research themes, technological

trends, methodological practices, and research gaps. The systematic review has ensured objectivity, reliability, and reproducibility in synthesizing knowledge about emerging AI applications in computer science.

Linkage among the Framework Components

The theoretical framework has illustrated that Computer Science has provided the foundational infrastructure, Artificial Intelligence has acted as the core paradigm, and Machine Learning has supplied the essential techniques enabling intelligent behavior. Emerging Applications have been the outcomes of the interaction among these components, reflecting the real-world impact of AI within computer science. The Systematic Review has functioned as an analytical tool that connects theory with existing empirical research, enabling a comprehensive understanding of how AI applications have evolved over time.

Relevance of the Framework to the Study

This theoretical framework has guided the organization and interpretation of the reviewed literature and has supported the achievement of the study objectives. By clearly defining and linking the key concepts, the framework has provided a coherent structure for analyzing emerging Artificial Intelligence applications in computer science. It has also facilitated the identification of research gaps and future research directions, thereby contributing to the advancement of knowledge in this rapidly evolving field.

This elaborated, point-wise theoretical framework has offered a clear conceptual foundation for understanding the role and evolution of Artificial Intelligence in Computer Science through emerging applications and systematic scholarly review.

Objectives Of The Study:

The present study has been undertaken with the following three objectives:

- To systematically review and analyze existing literature on emerging applications of Artificial Intelligence in the field of computer science.
- To identify and categorize major application areas and AI techniques used in recent computer science research.
- To examine current research trends, challenges, and future research directions related to Artificial Intelligence applications in computer science.

RESEARCH METHODOLOGY

The present study has adopted a systematic literature review (SLR) approach to examine emerging applications of Artificial Intelligence in the field of computer science. This methodology has been selected to ensure a structured, transparent, and reproducible analysis of existing scholarly research.

The review has been based entirely on secondary data, which have been collected from reputed academic databases such as IEEE Xplore, ACM Digital Library, ScienceDirect, SpringerLink, and Google Scholar. Research articles, review papers, and conference proceedings published mainly between 2015 and 2024 have been considered in order to capture recent developments in Artificial Intelligence applications.

A comprehensive keyword search strategy has been employed using terms such as Artificial Intelligence, Machine Learning, Deep Learning, Emerging AI Applications, and Computer Science. The identified studies have been screened through multiple stages, including title review, abstract screening, and full-text evaluation.

Only peer-reviewed articles published in English and directly related to AI applications in computer science have been included, while non-scholarly and irrelevant studies have been excluded. The selected literature has been systematically analyzed and categorized based on application domains, AI techniques, and research focus.

Finally, qualitative content analysis has been used to synthesize the findings, identify emerging trends, research gaps, and challenges, and draw meaningful conclusions. This systematic methodology has ensured reliability, validity, and academic rigor in achieving the objectives of the study.

The present study has been designed as a descriptive and exploratory research based on a systematic literature review approach. The research design has focused on collecting, analyzing, and synthesizing existing scholarly literature to examine emerging applications of Artificial Intelligence in computer science. Since the study aims to review and interpret previously published research rather than generate new primary data, a non-empirical research design has been adopted.

The study has relied exclusively on secondary data obtained from peer-reviewed journals, conference proceedings, academic books, and reputed online databases. A structured review framework has been followed to ensure consistency, transparency, and objectivity in selecting and analyzing relevant studies. The literature has been categorized based on application domains, AI techniques, and research trends to facilitate systematic analysis.

This research design has enabled a comprehensive understanding of the current state of Artificial Intelligence applications in computer science, identification of emerging trends, and recognition of research gaps. The descriptive-exploratory nature of the design **has ensured** that the study remains flexible while maintaining academic rigor, thereby effectively addressing the objectives of the research.

Tools And Techniques

The present study has employed qualitative research tools and techniques appropriate for a systematic literature review. Since the research is based on secondary data, no statistical or experimental tools have been used for primary data collection.

Academic databases such as IEEE Xplore, ACM Digital Library, ScienceDirect, SpringerLink, and Google Scholar have been used as major tools for sourcing relevant literature. Keyword-based search techniques have been applied using terms like Artificial Intelligence, Machine Learning, Deep Learning, Emerging AI Applications, and Computer Science to identify suitable research articles.

Screening and selection techniques have been adopted through title review, abstract screening, and full-text analysis to ensure relevance and quality of the selected studies. A systematic classification technique has been used to organize the literature according to application domains, AI techniques, and research focus areas.

Further, qualitative content analysis and thematic analysis techniques have been applied to synthesize findings, identify emerging trends, challenges, and research gaps. Reference management tools such as Mendeley and Zotero have been utilized to organize citations and ensure accuracy and consistency in referencing. These tools and techniques have ensured methodological rigor, reliability, and validity of the study.

Data Analysis and Interpretation:

In the present study, data analysis has been carried out through a qualitative and systematic examination of secondary data collected from peer-reviewed journals, conference proceedings, academic books, and reputed online databases. The selected literature has been carefully reviewed, compared, and synthesized to understand emerging applications of Artificial Intelligence in computer science.

The analysis has involved classifying the reviewed studies into major application domains such as machine learning and data analytics, natural language processing, computer vision, cyber security, software engineering, cloud computing, and Internet of Things-based systems. This classification has enabled identification of dominant research areas where AI techniques have been extensively applied. The analysis indicates that machine learning and deep learning models have been most frequently used, particularly in data-intensive and real-time applications.

Interpretation of the reviewed literature has revealed that recent research has increasingly focused on advanced AI techniques such as deep neural networks, generative AI, and explainable AI to improve system accuracy, automation, and transparency. Studies have highlighted that AI-driven systems have significantly enhanced decision-making, prediction accuracy, and operational efficiency across various computer science domains.

The analysis further has identified critical challenges discussed in the literature, including data privacy concerns, ethical issues, model interpretability, bias, and high computational costs. From the interpretation, it has been inferred that while AI applications in computer science have shown substantial progress, future research has to emphasize responsible AI development, improved transparency, and sustainable computing practices. Overall, the data analysis and interpretation have provided a comprehensive understanding of current trends, research gaps, and future directions in emerging Artificial Intelligence applications within computer science.

RESULTS AND DISCUSSION

The results of the present systematic review have revealed that Artificial Intelligence has become a central and transformative component of computer science, with rapidly expanding applications across multiple domains. The reviewed literature has shown that machine learning and deep learning techniques have been the most widely adopted AI approaches, particularly in areas such as data analytics, natural language processing, computer vision, and intelligent decision-support systems. These techniques have significantly improved accuracy, automation, and efficiency compared to traditional computational methods.

The findings have indicated that emerging applications of AI have increasingly focused on real-time and data-intensive environments, including cybersecurity systems, cloud computing platforms, and Internet of Things–enabled applications. AI-based intrusion detection systems, predictive maintenance models, and intelligent resource management frameworks have demonstrated superior performance in handling complex and dynamic data. This trend reflects the growing demand for adaptive and scalable AI solutions in modern computing environments.

The discussion of results further has highlighted the growing importance of explainable Artificial Intelligence and ethical AI practices. Several studies have emphasized the need for transparency, fairness, and accountability in AI models, especially in critical applications such as healthcare, finance, and security. The lack of interpretability in deep learning models has been identified as a major challenge that limits user trust and widespread adoption.

Additionally, the results have revealed persistent challenges related to data privacy, bias, high computational costs, and energy consumption. Although significant progress has been made, the discussion suggests that future research has to focus on developing efficient, interpretable, and ethically responsible AI systems. Overall, the results and discussion have confirmed that emerging applications of Artificial Intelligence have played a crucial role in advancing computer science, while also underscoring the need for balanced and sustainable AI development.

CONCLUSION

The present study has systematically reviewed emerging applications of Artificial Intelligence in the field of computer science and has provided a comprehensive synthesis of recent scholarly research. The review has demonstrated that Artificial Intelligence, particularly machine learning and deep learning techniques, has significantly transformed various domains such as data analytics, natural language processing, computer vision, cyber security, software engineering, cloud computing, and Internet of Things–based systems.

The findings have indicated that AI-driven applications have enhanced automation, accuracy, and decision-making capabilities in modern computing environments. At the same time, the study has identified critical challenges related to data privacy, ethical concerns, algorithmic bias, model interpretability, and high computational costs. These issues have emphasized the need for responsible, transparent, and sustainable AI development.

Overall, the study has concluded that while emerging applications of Artificial Intelligence have shown remarkable potential in advancing computer science, future research has to focus on developing explainable, secure, and ethically compliant AI systems. The insights generated from this systematic review have provided valuable guidance for researchers, academicians, and practitioners and have contributed to a deeper understanding of the evolving role of Artificial Intelligence in computer science.

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