

AI800 – Research Methodology in Computer Science

Literature Review

Big Data Analytics and Machine Learning: Applications, Challenges, and Future Directions

Big Data Analytics has become one of the most influential areas in computer science due to the rapid growth of digital data. Organizations increasingly rely on data-driven decision-making to improve efficiency, predict future trends, and gain competitive advantages. Machine learning techniques have further strengthened the value of big data analytics by enabling automated pattern recognition and predictive modeling. This literature review examines five recent studies published in 2024 that investigate major developments in big data analytics, including predictive analytics, explainable artificial intelligence, quality assurance, and large-scale data processing. The objective is to analyze current research trends, evaluate strengths and limitations of existing work, and identify future research opportunities.

Paper 1 – Big Data and Predictive Analytics: A Systematic Review of Applications

Summary of Objectives, Methodology, and Findings

The primary objective of this study was to examine how predictive analytics techniques are being applied across different industries. The authors conducted a systematic review of the literature and categorized applications into healthcare, finance, manufacturing, and public services. The findings demonstrated that predictive analytics significantly improves forecasting accuracy and supports strategic decision-making.

Critical Analysis

A major strength of this paper is its comprehensive coverage of application domains. The review provides clear evidence that predictive analytics can generate measurable organizational value. However, the study relies primarily on secondary sources and provides limited empirical validation of the proposed benefits.

Contribution to Understanding the Topic

This paper improved understanding of how data analytics transforms raw data into actionable knowledge. It highlighted the growing importance of machine learning algorithms in predictive systems.

Research Gap and Future Directions

Future research should focus on real-time predictive analytics, explainable prediction models, and cross-domain performance evaluation.

Paper 2 – 15 Years of Big Data: A Systematic Literature Review

Summary of Objectives, Methodology, and Findings

This study reviewed fifteen years of big data research to identify major trends and technological developments. The authors analyzed a large collection of academic publications and classified them according to research themes and application areas. Results revealed significant growth in cloud computing, distributed systems, and machine learning integration.

Critical Analysis

The paper offers an excellent historical perspective and presents a structured overview of the evolution of big data technologies. Its primary limitation is the limited discussion of practical implementation challenges faced by organizations.

Contribution to Understanding the Topic

The review helped establish a broader understanding of the progression of data analytics from traditional business intelligence systems to advanced AI-driven solutions.

Research Gap and Future Directions

Additional research is required to investigate long-term sustainability, energy efficiency, and governance issues associated with large-scale analytics platforms.

Paper 3 – Big Data Applications: Overview, Challenges and Future

Summary of Objectives, Methodology, and Findings

This research focused on practical applications of big data technologies and the challenges associated with implementation. The authors examined sectors such as healthcare, transportation, education, and smart cities. The findings indicated substantial benefits in operational efficiency, service quality, and decision support.

Critical Analysis

A notable strength is the strong emphasis on real-world applications. The study successfully connects theoretical concepts with practical outcomes. Nevertheless, the discussion lacks extensive quantitative comparisons between different analytics approaches.

Contribution to Understanding the Topic

The paper demonstrated how data analytics contributes to digital transformation and innovation across multiple industries.

Research Gap and Future Directions

Future studies should explore privacy-preserving analytics techniques and scalable architectures capable of supporting growing data volumes.

Paper 4 – Explainable Big Data Analytics Using Self-Structuring Artificial Intelligence

Summary of Objectives, Methodology, and Findings

The objective of this paper was to develop a cloud-based architecture that improves transparency in machine learning-driven analytics. The researchers proposed an explainable AI framework capable of providing interpretable results while maintaining analytical performance. Experimental evaluation showed promising improvements in model transparency.

Critical Analysis

The main strength lies in addressing one of the most important challenges in modern AI systems: explainability. A limitation is the relatively small-scale validation environment used during testing.

Contribution to Understanding the Topic

This study emphasized the importance of trust and accountability in data analytics systems. It showed that analytical accuracy alone is insufficient without transparent decision-making processes.

Research Gap and Future Directions

Future work should evaluate explainable analytics frameworks across larger datasets and diverse industry sectors.

Paper 5 – Quality Assurance Strategies for Machine Learning Applications in Big Data Analytics

Summary of Objectives, Methodology, and Findings

This paper investigated quality assurance methods for machine learning systems operating within big data environments. The authors analyzed quality attributes such as reliability, robustness, fairness, scalability, and security. Results indicated that quality assurance is essential for maintaining trustworthy analytics outcomes.

Critical Analysis

The paper provides valuable insights from a software engineering perspective and addresses practical concerns often overlooked in analytics research. However, additional industrial case studies would strengthen the conclusions.

Contribution to Understanding the Topic

The study expanded understanding of how quality management practices influence the success of analytics systems.

Research Gap and Future Directions

Future research should focus on standardized evaluation frameworks and automated quality assessment mechanisms.

Comparative Discussion

The reviewed studies collectively demonstrate that big data analytics is evolving beyond simple data processing toward intelligent and explainable decision-support systems. While predictive analytics remains a dominant application area, researchers increasingly emphasize transparency, fairness, privacy, and system quality. A recurring theme across all studies is the integration of machine learning techniques with large-scale distributed data environments. Another common observation is the need for more standardized evaluation methods and stronger governance frameworks.

Conclusion

The literature indicates that big data analytics plays a critical role in modern computer science and organizational decision-making. Recent research highlights the growing importance of machine learning, explainable AI, and quality assurance practices. Despite substantial progress, challenges related to scalability, privacy, interpretability, and governance remain unresolved. Future research should prioritize trustworthy analytics systems capable of providing accurate, transparent, and ethical outcomes.

References (APA 7th Edition)

Jamarani, A., et al. (2024). Big data and predictive analytics: A systematic review of applications. *Artificial Intelligence Review*, 57, 176.

Tosi, D., Kokaj, R., & Rocchetti, M. (2024). 15 years of Big Data: A systematic literature review. *Journal of Big Data*, 11, 73.

Badshah, A., et al. (2024). Big data applications: Overview, challenges and future. *Artificial Intelligence Review*, 57, 290.

Mills, N., et al. (2024). A cloud-based architecture for explainable Big Data analytics using self-structuring artificial intelligence. *Discover Artificial Intelligence*, 4, 33.

Ogrizovi█, M., Draškovi█, D., & Boji█, D. (2024). Quality assurance strategies for machine learning applications in big data analytics: An overview. *Journal of Big Data*, 11, 156.