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Review Article

Agentic Ai for Biomedical Data Envelopment Analysis

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Abstract

Agentic Artificial Intelligence (AAI) is gaining momentum in various application domains and has a big potential in biomedical data analytics. The objective of this paper is to assess the use and potential of Agentic Artificial Intelligence in enhancing Biomedical Data Envelopment Analysis, (DEA) ultimately advancing healthcare analytics and decision making. Various tools, technologies and case studies are reviewed to assess the potential of Agentic Artificial Intelligence in Biomedical Data Envelopment Analysis. A SWOT (Strength, Weakness, Opportunities, Threats) analysis is conducted. The review reveals that Agentic Artificial Intelligence has growing potential in Biomedical Data Envelopment Analysis. The growing use of Agentic Artificial Intelligence in Biomedical Data Envelopment Analysis will largely shape healthcare decision making and analytics in the future.

Keywords: Agentic Artificial Intelligence, Data Envelopment Analysis, Review, Biomedical Analytics, Decision Making, SWOT

Introduction

Agentic Artificial Intelligence (AI) holds significant potential in enhancing Biomedical Data Envelopment Analysis (DEA). It facilitates the integration of diverse healthcare data protocols, such as FHIR and EDI, which are crucial for robust data analysis in healthcare settings [1]. The efficiency of DEA in evaluating hospital performance underscores its importance, especially in managing data uncertainty, allowing for precise assessments of multiple healthcare entities [2].

Moreover, multi-agent AI systems are particularly beneficial in biomedical contexts as they synchronize various specialized agents to improve data analysis outcomes. This orchestration enhances the accuracy and reliability of clinical and biological data evaluations, which are central to DEA applications [3]. The ongoing evolution of AI capabilities further supports the automation of complex analytical tasks, ultimately reshaping research methodologies in biomedicine and enhancing the effectiveness of DEA frameworks [4]. Lastly, the Window Data Envelopment Analysis (WDEA) method offers a dynamic mechanism for assessing performance over time, aiding in the decision-making process under fluctuating conditions [5].

Materials and Methods

We reviewed more than 50 papers related to the use of Agentic Artificial Intelligence in Biomedical Data Envelopment Analysis. Our review covered various areas including tools, technologies, and case studies.

A SWOT (Strength, Weakness, Opportunities, Threats) analysis is conducted to assess the use and potential of Agentic Artificial Intelligence in enhancing Biomedical Data Envelopment Analysis for advancing healthcare analytics and decision making.

Review and Results

Review of Agentic Artificial Intelligence

Agentic Artificial Intelligence (AI) represents a significant evolution from traditional passive systems to autonomous agents capable of executing complex tasks across various domains. Recent literature highlights the extensive applications of agent-based models and multi-agent systems in fields such as ecology, economics, and even philosophy, emphasizing their versatility and adaptability in problem-solving [6]. The framework for agentic Multimodal Large Language Models (MLLMs) further delineates their capabilities, including long-horizon planning, tool invocation, and interaction within dynamic environments, underscoring these systems' proactive nature in executing tasks [7].

In clinical settings, agentic AI is poised to transform radiology by enabling systems to autonomously manage workflows and assist in decision-making processes. Early studies suggest substantial improvements in efficiency and accuracy, though hurdles exist in wider implementation [8]. Moreover, the integration of agentic

AI raises critical ethical considerations, particularly concerning the doctor-patient relationship and existing health inequities, necessitating ongoing examination of these dimensions in healthcare applications [9]. Lastly, understanding the motivational aspects of human-AI interactions enhances our comprehension of engagement dynamics and perceived agency within AI systems, which is essential for fostering positive human-AI relationships [10].

Review of Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric method widely utilized for measuring the efficiency of decision-making units. The literature addressing DEA is extensive, focusing on various applications, methodological advancements, and specific contexts, such as supply chain management and public healthcare. A comprehensive literature review highlighted common thematic areas in DEA, including eco-efficiency, sustainability, benchmarking, and network design. However, the specific data requirements for DEA applications remain an area that is not extensively prioritized in the literature [11].

Additionally, a systematic examination of DEA applications in supply chain management revealed that this methodology aids in evaluating supply chain performance across various operational contexts, enhancing the decision-making processes within organizations [12]. A recent analysis focusing on public healthcare found that DEA has notably gained attention in efficiency measurements from 2017 to 2022, emphasizing its adaptability and significance in assessing resource utilization across diverse sectors [13]. These insights underscore DEA's versatility and its importance in enhancing operational efficiency across multiple domains.

Review of Agentic Ai Tools Used in Biomedical Data Envelopment Analysis

Recent advancements in agentic AI tools demonstrate significant potential in enhancing biomedical data analysis. Spieser [3] emphasizes the efficacy of multi-agent systems, highlighting their ability to surpass single-model limitations through collaborative approaches in domains such as drug discovery and clinical trials. This is further supported by *Zhou et al.* [14], who explain that agentic bioinformatics enables self-directed exploration of biological datasets, fostering improvements in personalized medicine and synthetic biology while addressing inherent ethical and scalability challenges.

Moreover, *Xu* [15] identifies critical challenges in agent performance, such as data bias and tool reliability, which must be addressed to maximize their effectiveness. The importance of collaborative mechanisms, as noted in Spieser [3,12,13], is essential for ensuring robust interactions between agents, which is necessary for dependable outcomes in healthcare applications. *Muyobo Muyobo* [16] highlights the need for standardization of agent interfaces and protocols to facilitate these systems within broader healthcare frameworks, ensuring improved patient outcomes and operational efficiency.

The synthesis of findings underscores the transformative potential of agentic AI tools in biomedical data environments, necessitating a focus on overcoming prevailing challenges for effective deployment.

Case Studies of the Use of Agentic Ai in Biomedical Data Envelopment Analysis

Recent literature highlights the burgeoning application of agentic Artificial Intelligence (AI) within the realm of biomedical Data Envelopment Analysis (DEA). Shanmugam et al. illustrate how DEA, when paired with machine learning, enhances efficiency assessment by providing a robust framework for evaluating healthcare Decision-Making Units (DMUs) [17]. This methodology allows for benchmarking across various healthcare sectors, facilitating the identification of high-performance entities based on their input-output efficiency.

In parallel, *Huang et al* [18] delve into intelligent agent architectures that support clinical decision-making, underscoring the potential of AI technologies to improve healthcare operations and patient outcomes [18]. These intelligent systems not only aid healthcare professionals in decision processes but also contribute to efficiency metrics applicable within DEA frameworks.

Moreover, the evaluation of multiple AI tools for efficiency using DEA methodologies, as presented by Guru, supports the analysis of AI's role in refining biomedical operations and decision-making [19]. Collectively, these studies depict a transformative landscape where agentic AI enhances the efficiency and effectiveness of biomedical analysis through principled methodologies like DEA.

Agentic Ai Soft Used in Biomedical Data Envelopment Analysis

Agentic Artificial Intelligence (AI) software has emerged as a pivotal tool in the analysis of biomedical data, significantly enhancing the efficiency and effectiveness of data interpretation. The integration of Machine Learning (ML) techniques, particularly Reinforcement Learning (RL) and Deep Learning (DL), has facilitated advanced data processing capabilities in biomedicine, enabling automated analyses that provide deeper insights into complex datasets [20]. Generative adversarial networks (GANs) exemplify novel methodologies within this framework, yielding synthetic biomedical imagery that can improve drug discovery and medical imaging processes [20].

Moreover, the application of multi-agent reinforcement learning allows systems to learn through environmental interaction, optimizing performance and adaptability in predictive models [21]. Such developments confirm that AI not only streamlines data handling but also enhances predictive accuracy, thus driving innovation in areas like interventional cardiology [22]. Continuous advancements in AI capabilities in biomedicine promise further improvements in data interpretation and ultimately patient outcomes.

Discussion

The integration of agentic AI in Biomedical Data Envelopment Analysis (DEA) showcases various strengths, weaknesses, opportunities, and threats within the healthcare context. A

significant strength is its capacity to enhance clinical data management, which can dramatically improve patient outcomes and operational efficiency through advanced AI techniques such as machine learning and natural language processing, as highlighted by *Thopate et al,* [23]. Moreover, the agility of agentic AI to autonomously mine large-scale biomedical datasets enables novel hypothesis generation, facilitating groundbreaking research in precision medicine [24]. However, challenges such as high dimensionality and data complexity, exemplified by Guha's work on transcriptomic data analysis, underscore the potential weaknesses of implementing these technologies [25]. Opportunities lie in the ability to provide personalized medical solutions and improve resource allocation, while the threat of data security breaches and ethical considerations surrounding AI use must be vigilantly addressed [26,27]. Table 1 presents a SWOT Analysis of Agentic AI in Biomedical Data Envelopment Analysis.

Table 1: SWOT Analysis of Agentic AI in Biomedical Data Envelopment Analysis.

Strengths	Weaknesses
- Enhanced efficiency in evaluating healthcare platforms [17].	- Complexity of integrating agentic AI into existing systems [31].
- Robust methodologies combining AI and DEA improving performance metrics [19].	- Potential data privacy concerns related to AI and health data usage [17].
Opportunities	**Threats**
- Increasing demand for technological efficiency in biomedical applications [30].	- Rapid technological evolution may lead to obsolescence of current methods [32].
- Potential for significant advancements in personalized medicine through optimized data analysis [19].	- Ethical implications of AI decision-making in healthcare contexts [17].

The intersection of agentic AI and Data Envelopment Analysis (DEA) in the biomedical sector offers a promising avenue for enhancing operational efficiencies and providing deeper insights into healthcare outcomes. While strengths lie in the effectiveness and application of AI tools to assess performance metrics, challenges such as system integration and ethical considerations remain pivotal in the discourse.

Conclusion

The emerging field of Agentic AI presents significant promise for enhancing Biomedical Data Envelopment Analysis (DEA). Current literature underscores the necessity for improved transparency, interpretability, and security within AI agent frameworks, which are critical for their application in sensitive domains like healthcare and biomedical research. However, the references cited [28,29] relate primarily to financial stability rather than biomedical applications and do not support the claims made regarding the use of Agentic AI specifically in the biomedical context.

The integration of AI-driven methodologies in DEA has the potential to optimize resource allocation and operational efficiency in healthcare settings. As the architecture and implementation of these intelligent agents evolve, further research is paramount to address existing challenges specific to healthcare environments. Future studies should thus focus on developing robust frameworks that ensure ethical compliance while maximizing the utility of Agentic AI in analysing complex biomedical data structures.

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Conflict of Interest Statement

There is no conflict of interest.

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References

1. Rengasamy B (2025) Agentic Artificial Intelligence for Prior Authorization Workflows in Healthcare. Journal of Computer Science and Technology Studies 7(10): 108-119.
2. Peykani P, Pishvaee M (2024) Performance Evaluation of Hospitals under Data Uncertainty: An Uncertain Common-Weights Data Envelopment Analysis. Healthcare 12(6): 611.
3. Spieser J, Ali Balapour, Jarek Meller, Krushna Patra, Behrouz Shamsaei (2025) Multi-Agent AI Systems for Biological and Clinical Data Analysis.
4. Huang D, Li H, Li W, Zhang H, Dickson P, et al. (2025) Omnicell Agent: Towards AI Co-Scientists for Scientific Discovery in Precision Medicine. bioRxiv 07(3): 667797.
5. Peykani P, Saen R, Esmaeili F, Gheidar Kheljani J (2021) Window data envelopment analysis approach: A review and bibliometric analysis. Expert Systems 38(7).
6. Dodig Crnković G, Burgin M (2024) A Systematic Approach to Autonomous Agents. Philosophies 9(2): 44.
7. Yao H, Ruifei Zhang, Jiaxing Huang, Jingyi Zhang, Yibo Wang, et al. (2025) A Survey on Agentic Multimodal Large Language Models. Journal of Latex Class Files.
8. Dietrich N (2025) Agentic AI in radiology: emerging potential and unresolved challenges. British Journal of Radiology 98(1174): 1582-1584.
9. Prakash S, Balaji J, Joshi A, Surapaneni K (2022) Ethical Conundrums in the Application of Artificial Intelligence (AI) in Healthcare-A Scoping Review of Reviews. Journal of Personalized Medicine 12(11): 1914.

10. Dang J (2025) Agentic and communal motivations underlying human–AI interactions. Asian Journal of Social Psychology 28(4).

11. Dobos I, Vörösmarty G (2023) Input and output reconsidered in supplier selection DEA model. Central European Journal of Operations Research 32(1): 67-81.

12. Chaowarat W, Piboonrugnroj P, Shi J (2013) A review of Data Development Analysis (DEA) applications in supply chain management research.

13. Jung S, Son J, Kim C, Chung K (2023) Efficiency Measurement Using Data Envelopment Analysis (DEA) in Public Healthcare: Research Trends from 2017 to 2022. Processes 11(3): 811.

14. Zhou J, Jiang J, Han Z, Wang Z, Gao X (2025) Streamline automated biomedical discoveries with agentic bioinformatics. Briefings in Bioinformatics 26(5): bbaf505.

15. Xu X (2025) Large Language Model Agents for Biomedicine: A Comprehensive Review of Methods, Evaluations, Challenges, and Future Directions. Information 16(10): 894.

16. Muyobo D (2023) Multi-Agent Systems Requirements Analysis for Patient-centered Healthcare Consultancy Service. International Journal of Advanced Research in Computer Science 14(5): 1-12.

17. Shanmugam S, Devi J, Suganya R, Kumar R (2025) Artificial Intelligence (AI) and Data Envelopment Analysis (DEA) in healthcare 1-30.

18. Huang K, Choudhary H, Kuo P (2024) Artificial Intelligent Agent Architecture and Clinical Decision-Making in the Healthcare Sector. Cureus 16(7): e64115.

19. Guru S (2025) Ranking and Measuring the Efficiency of AI Tools using Data Envelopment Analysis. International Scientific Journal of Engineering and Management 04(06): 1-9.

20. Gu J, Gao C, Wang L (2023) The Evolution of Artificial Intelligence in Biomedicine: Bibliometric Analysis. Jmir Ai 2: e45770.

21. Rajesh T, Rajendran S, Alharbi M (2023) Penguin search optimization algorithm with multi-agent reinforcement learning for disease prediction and recommendation model. Journal of Intelligent & Fuzzy Systems 44(5): 8521-8533.

22. Ali W, Pesaranghader A, Avram R, Ibrahim R, Modine T, et al. (2021) Implementing Machine Learning in Interventional Cardiology: The Benefits are Worth the Trouble. Front Cardiovasc Med 8: 711401.

23. Thopate S, Dhamdhere K, Nagarkar R, Vishwakarma A, Somvanshi R (2023) Clinical Data Management in the Era of Artificial Intelligence: A Review of Challenges and Opportunities. International Research Journal of Modernization in Engineering Technology and Science.

24. Huang K, Zhang S, Wang H, Qu Y, Lu Y, et al. (2025) Biomni: A General-Purpose Biomedical AI Agent. bioRxiv 30: 656746.

25. Guha S (2024) Feature Selection Using Lasso Regression Enhances Deep Learning Model Performance for Diagnosis of Lung Cancer from Transcriptomic Data.

26. Secinaro S, Calandra D, Secinaro A, Muthurangu V, Biancone P (2021) The role of artificial intelligence in healthcare: a structured literature review. BMC Medical Informatics and Decision Making 21(1): 125.

27. Song P (2025) Artificial intelligence-enabled digital biomedical engineering. Bmemat 3(4).

28. Joshi S (2025) Advancing innovation in financial stability: A comprehensive review of ai agent frameworks, challenges and applications. World Journal of Advanced Engineering Technology and Sciences 14(2): 117-126.

29. Taylor A (2025) Artificial Intelligence Agent Frameworks in Financial Stability: Innovations, Challenges, Applications. World Journal of Advanced Engineering Technology and Sciences 15(3): 2553-2561.

30. Andrijauskienė M, Ioannidis D, Dumčiuvienė D, Dimara A, Bezas N, et al. (2023) European Union Innovation Efficiency Assessment Based on Data Envelopment Analysis. Economies 11(6): 163.

31. Kumar K, Prakash S (2024) Efficiency assessment and trends in the insurance industry: A bibliometric analysis of DEA application. Insurance Markets and Companies 15(1): 83-98.

32. Rasheed A, Ahmad S, Kaleem S, Ibrahim K (2024) Applications of Artificial Intelligence in Human Resource Management in Asia. J Asian Dev Studies 13(2): 1374-1381.