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Explainable AI in Healthcare: Enhancing Transparency and Trust upon Legal and Ethical Consideration

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Abstract- *As artificial intelligence (AI) continues to make significant advancements in healthcare, there is a growing need to ensure the transparency and trustworthiness of AI-driven clinical decision-making. Explainable AI (XAI) has emerged as a promising approach to address this challenge by providing clear and interpretable explanations for the predictions and recommendations made by AI algorithms. This research paper explores the application of XAI techniques in healthcare and examines their impact on improving patient outcomes, clinician trust, and regulatory compliance. Various XAI methods, such as rule-based models, decision trees, and model-agnostic techniques, are discussed in the context of healthcare research, and their potential benefits and limitations are explored. Additionally, ethical considerations, challenges, and future directions for integrating XAI into healthcare systems are also discussed.*

Keywords: *Explainable AI, Trust in AI, Transparency in AI, Healthcare, Decision making.*

I. INTRODUCTION

Artificial intelligence (AI) has shown great potential in revolutionizing healthcare by enabling more accurate diagnoses, personalized treatments, and efficient healthcare delivery. However, the lack of transparency and interpretability in AI algorithms poses challenges for clinicians, patients, and regulatory bodies. Explainable AI (XAI) seeks to address these challenges by providing clear explanations for the decisions made by AI models, thereby increasing trust, understanding, and accountability in healthcare settings.

The increasing adoption of AI in healthcare has raised concerns about the "black box" nature of these algorithms. Clinicians and patients often find it difficult to trust and rely on AI-driven recommendations without understanding the underlying reasoning. Moreover, regulatory bodies require transparency to ensure patient safety, ethical compliance, and regulatory standards. XAI offers a solution to bridge the gap between the inherent complexity of AI models and the need for understandable decision-making processes in healthcare. The primary objectives of this research paper are to:

- Explore the concept of XAI and its significance in healthcare.
- Investigate the different techniques and methods used for achieving explainability in AI models.
- Examine the applications of XAI in healthcare research and clinical practice.
- Discuss the evaluation and validation approaches for XAI in healthcare.
- Highlight the challenges and limitations associated with implementing XAI in healthcare settings.
- Suggest future directions for advancing XAI in healthcare research and practice.

II. LITERATURE REVIEW

Explainable AI (XAI) has gained significant attention in healthcare due to its potential to enhance transparency, interpretability, and trust in AI-based systems used for clinical decision-making. This literature review aims to explore previous research focused on the development and application of XAI techniques in healthcare, specifically emphasizing the importance of transparency, trust, and considering legal and ethical considerations. By analyzing the selected research papers, this review aims to provide insights into the significance of XAI in healthcare and its impact on building trust among clinicians, patients, and AI systems [10-15].

TABLE I. LITERATURE REVIEW

Author and Year	Paper Title	Summary
Dosilovi6, F. K., Brci6, M., & Hlupi6, N. (n.d.)	Explainable Artificial Intelligence: A Survey.	The paper discusses the issue of lack of transparency and interpretability in many state-of-the-art machine learning models, which is a major drawback in applications such as healthcare and finance. The paper summarizes

		recent developments in explainable artificial intelligence (XAI) in supervised learning and proposes further research directions.
Ma, X., Niu, Y., Gu, L., Wang, Y., Zhao, Y., Bailey, J., & Lu, F. (2021)	Understanding adversarial attacks on deep learning based medical image analysis systems.	This paper states that deep learning based medical image analysis systems can be compromised by adversarial attacks with small imperceptible perturbations, which raises safety concerns about their deployment in clinical settings. The paper provides a deeper understanding of adversarial examples in the context of medical images, finds that medical DNN models can be more vulnerable to adversarial attacks compared to models for natural images, and suggests that these findings may be useful to design more explainable and secure medical deep learning systems.
Ward, A., Sarraju, A., Chung, S., Li, J., Harrington, R., Heidenreich, P., Palaniappan, L., Scheinker, D., & Rodriguez, F. (2020)	Machine learning and atherosclerotic cardiovascular disease risk prediction in a multi-ethnic population.	The paper aims to develop machine learning models for predicting atherosclerotic cardiovascular disease (ASCVD) risk in a multi-ethnic population using an electronic health record (EHR) database from Northern California. The models achieved comparable or improved performance compared to the pooled cohort equations (PCE) while allowing risk discrimination in a larger group of patients including PCE-ineligible patients.
Li, W., Song, Y., Chen, K., Ying, J., Zheng, Z., Qiao, S., Yang, M., Zhang, M., & Zhang, Y. (2021)	Predictive model and risk analysis for diabetic retinopathy using machine learning: A retrospective cohort study in China.	The paper aims to investigate the risk factors and predictive models for diabetic retinopathy (DR) using machine learning techniques. The study was conducted retrospectively on a large sample dataset of inpatients with type-2 diabetes mellitus (T2DM) in a Chinese central tertiary hospital in Beijing.
Bharati, S., Mondal, M. R. H., & Podder, P. (2023)	A Review on Explainable Artificial Intelligence for Healthcare: Why, How, and When	The paper provides a systematic analysis of explainable artificial intelligence (XAI) in the field of healthcare, focusing on the prevailing trends, major research directions, and implications of XAI models. It also presents a comprehensive examination of XAI methodologies and how a trustworthy AI can be derived for healthcare fields.
Amann, J., Blasimme, A., Vayena, E., Frey, D., & Madai, V. I. (2020)	Explainability for artificial intelligence in healthcare: a multidisciplinary perspective	This paper provides a comprehensive assessment of the role of explainability in medical AI and makes an ethical evaluation of what explainability means for the adoption of AI-driven tools into clinical practice. The authors adopted a multidisciplinary approach to analyze the relevance of explainability for medical AI from the technological, legal, medical, and patient perspectives. They performed a conceptual analysis of

		the pertinent literature on explainable AI in these domains and identified aspects relevant to determining the necessity and role of explainability for each domain, respectively. Drawing on these different perspectives, they then concluded by distilling the ethical implications of explainability for the future use of AI in the healthcare setting. The paper aims to draw attention to the interdisciplinary nature of explainability and its implications for the future of healthcare.

III. EXPLAINABLE AI IN HEALTHCARE

A. Definition and Importance of Explainable AI

Explainable AI refers to the capability of AI systems to provide human-understandable explanations for their decisions and recommendations. It enables clinicians and patients to comprehend the factors that contribute to an AI model's output, fostering trust and facilitating informed decision-making. The importance of explainability in healthcare lies in enhancing patient safety, improving clinical decision-making, enabling effective collaboration between clinicians and AI, and ensuring ethical and regulatory compliance [1].

B. Explainability Challenges in Healthcare

Healthcare poses unique challenges for achieving explainability in AI models. The complexity of medical data, the need for domain-specific knowledge, and the potential impact of AI decisions on patients' lives make explainability crucial. However, healthcare data often comprises heterogeneous and unstructured formats, making it challenging to interpret AI outputs. Additionally, the interpretability-accuracy trade-off and the dynamic nature of medical knowledge further complicate explainability in healthcare [2].

C. Benefits of Explainable AI in Clinical Decision-Making

Explainable AI offers several benefits in clinical decision-making. It enables clinicians to understand the reasoning behind AI recommendations, aiding in treatment planning and patient management. Patients can gain insights into the basis of their diagnosis or treatment options, empowering them to make informed decisions and enhancing their trust in AI. Moreover, explainability facilitates regulatory compliance, audits, and accountability, fostering transparency and fairness [3-5].

D. Legal Considerations in Explainable AI

The adoption of Explainable AI (XAI) in healthcare is subject to various legal considerations. While the specific legal landscape may vary depending on the jurisdiction, here are some key legal aspects to consider [6,7]]:

1) Data protection and privacy: Healthcare data is often subject to stringent data protection laws and regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States or the General Data Protection Regulation (GDPR) in the European Union. When implementing XAI in healthcare, organizations must ensure compliance with these regulations to protect patient privacy and secure the handling of personal health information [8].

2) Informed consent: Informed consent is a fundamental legal requirement in healthcare. When using AI systems, including XAI, it is important to obtain informed consent from patients, clearly explaining the purpose, potential risks, and benefits of AI-driven interventions or decision-making. Patients should be informed about the involvement of AI systems and have the option to choose alternatives or opt-out if desired [9].

3) Medical device regulations: Depending on the jurisdiction, AI systems used in healthcare may be subject to medical device regulations. Regulatory bodies, such as the Food and Drug Administration (FDA) in the United States or the European Medicines Agency (EMA) in the European Union, may classify certain AI systems as medical devices. Compliance with relevant regulations, such as obtaining necessary approvals or clearances, may be required before deploying XAI in healthcare setting [10].

4) Liability and malpractice: The introduction of AI systems, including XAI, raises questions about liability and responsibility in case of errors or adverse outcomes. It is important to consider who holds liability when an AI system is involved in decision-making. Healthcare providers and organizations should assess and address potential risks and establish protocols for handling situations where AI recommendations may conflict with clinical judgment.

5) Intellectual property rights: Organizations developing and deploying XAI systems need to consider intellectual property rights, including patents, copyrights, and trade

secrets. Protecting the algorithms, models, and other proprietary components of the XAI system may be crucial to ensure ownership and prevent unauthorized use or replication by competitors.

6) Regulatory transparency and audits: Some jurisdictions are exploring regulations that require transparency and audits for AI systems used in critical domains such as healthcare. This may involve making the inner workings of the AI system, including XAI, accessible for regulatory inspections and audits to ensure compliance with legal and ethical standards [11].

E. Ethical Considerations in Explainable AI

The ethical considerations surrounding Explainable AI (XAI) in healthcare are crucial for ensuring responsible and beneficial deployment. Here are some key ethical considerations to bear in mind [12-15]:

1) Transparency and accountability: XAI should prioritize transparency and provide understandable explanations for its decisions. This promotes accountability by allowing healthcare professionals and patients to comprehend the reasoning behind AI-generated recommendations or diagnoses. Transparent AI systems help avoid the "black box" problem, enabling users to trust and validate the outputs.

2) Fairness and bias mitigation: AI systems trained on biased data may perpetuate and amplify existing biases, potentially leading to discriminatory outcomes in healthcare. Ethical XAI implementation involves careful consideration and active mitigation of biases during the data collection, preprocessing, and model training stages. Monitoring and addressing bias in XAI systems can contribute to more equitable healthcare practices.

3) Informed consent and human involvement: Patients have the right to be informed about the involvement of AI, including XAI, in their healthcare. Clear communication regarding the role, limitations, and potential risks of AI systems is essential to obtain informed consent. Patients should have the option to receive human explanations and guidance, ensuring that their autonomy and preferences are respected.

4) Patient-centered care: Ethical XAI should prioritize patient well-being and ensure that decisions made by AI systems align with the best interests of the patient. XAI should be designed to support healthcare professionals and enhance their decision-making process, considering the unique circumstances and preferences of individual patients.

5) Continual evaluation and improvement: Ethical XAI implementation involves ongoing evaluation and improvement of the system's performance. Regular monitoring, feedback collection, and incorporating user input help identify and rectify any issues, biases, or errors in the AI system. Continuous improvement contributes to better healthcare outcomes and ethical practice.

6) Professional responsibility and education: Healthcare professionals have a responsibility to understand and use XAI systems appropriately. This includes being knowledgeable about the limitations and potential biases of AI systems, maintaining their clinical expertise, and critically evaluating the outputs of AI. Adequate education and training on XAI should be provided to healthcare professionals to ensure its responsible and effective use.

7) Ethical frameworks and guidelines: Following established ethical frameworks, such as the principles of beneficence, non-maleficence, autonomy, and justice, can guide the development and deployment of XAI in healthcare. Ethical guidelines specific to AI in healthcare, such as those provided by professional medical organizations or governmental bodies, can help navigate the unique ethical challenges presented by XAI.

Addressing these ethical considerations fosters responsible and ethical deployment of XAI in healthcare. Organizations and healthcare professionals should prioritize patient well-being, fairness, transparency, and accountability to ensure that XAI systems align with ethical standards and contribute to improved healthcare outcomes.

IV. XAI TECHNIQUES IN HEALTHCARE

A. Rule-based Models

Rule-based models utilize a set of predefined rules to make decisions. These models provide high interpretability, as the decision process follows explicit rules that can be understood and validated by clinicians. However, their performance may be limited in complex and dynamic healthcare domains [16, 17].

B. Decision Trees and Rule

Extraction Decision trees are hierarchical structures that represent decision processes based on features and conditions. They provide interpretable paths for decision-making, making them suitable for explainable AI in healthcare. Rule extraction techniques can convert complex AI models into rule-based representations, enhancing interpretability without sacrificing accuracy [18].

C. Model-Agnostic Approaches (e.g., LIME, SHAP) Model:

Agnostic approaches aim to provide explanations for any type of AI model by analyzing their inputs and

outputs. Local Interpretable Model-Agnostic Explanations (LIME) and SHapley Additive exPlanations (SHAP) are popular techniques that assign importance values to features, highlighting their contributions to the model's predictions. These methods enable clinicians and patients to understand the rationale behind AI decisions at the individual instance level.

D. Hybrid Approaches

Hybrid approaches combine multiple XAI techniques to leverage their strengths and mitigate their limitations. These approaches often involve a combination of rule-based models, decision trees, and model-agnostic techniques to provide comprehensive and interpretable explanations in healthcare.

V. APPLICATIONS OF XAI IN HEALTHCARE

A. Disease Diagnosis and Prognosis

XAI can aid clinicians in understanding the factors influencing disease diagnosis and prognosis. By providing interpretable explanations, clinicians can validate AI recommendations and make well-informed treatment decisions. Patients also benefit from understanding the reasoning behind their diagnosis, promoting trust and engagement in their healthcare journey.

B. Treatment Recommendation Systems

Explainable AI can assist in treatment recommendation systems by providing transparent explanations for the suggested treatments. Clinicians can evaluate the reasoning behind AI recommendations, ensuring that they align with clinical guidelines and patient-specific factors. This promotes shared decision-making between clinicians and patients, leading to more personalized and effective treatment plans.

C. Clinical Decision Support Systems

XAI plays a vital role in clinical decision support systems by offering transparent explanations for the suggested interventions or actions. Clinicians can assess the factors considered by AI models and make well-grounded decisions based on the provided explanations. This empowers clinicians to trust and utilize AI as a valuable tool in their decision-making process.

D. Patient Monitoring and Personalized Medicine

In patient monitoring and personalized medicine, XAI enables the interpretation of AI models that analyze patient data and provide individualized insights. Clinicians can understand the underlying factors that contribute to AI-driven recommendations, facilitating tailored interventions and improving patient outcomes. Moreover, patients can gain insights into their health status and the basis for personalized treatment plans.

VI. EVALUATING AND VALIDATING XAI IN HEALTHCARE

A. Quantitative Evaluation Metrics

Quantitative evaluation metrics assess the performance and interpretability of XAI techniques. Metrics such as accuracy, fidelity, and stability measure the alignment between the AI model's explanations and its predictions. Additionally, metrics like understandability and trustworthiness capture the subjective perception of clinicians and patients regarding the interpretability of AI explanations.

B. User-centric Evaluation Methods

User-centric evaluation methods involve conducting user studies and gathering feedback from clinicians and patients. These methods assess the usefulness, comprehensibility, and impact of XAI in real-world healthcare scenarios. User feedback provides valuable insights for refining and improving XAI systems to meet the needs and expectations of end-users.

C. Regulatory Compliance and Explainability

Explainability is crucial for regulatory compliance in healthcare. Regulatory bodies require transparency and accountability in AI systems to ensure patient safety, ethical standards, and compliance with legal frameworks. XAI can facilitate the auditability and explainability required for regulatory approval and adherence to healthcare regulations.

VII. CHALLENGES AND LIMITATIONS

A. Complexity and Scalability

Healthcare data is complex, diverse, and voluminous, posing challenges for XAI techniques. Ensuring scalability and efficiency in handling large datasets and complex AI models remains a challenge. Developing XAI methods that can handle the complexity and scale of healthcare data is essential for their widespread adoption.

B. Balancing Interpretability and Accuracy

There is often a trade-off between interpretability and accuracy in AI models. Highly interpretable models may sacrifice predictive performance, while complex models may be difficult to interpret. Striking the right balance between interpretability and accuracy is a challenge that needs to be addressed in XAI for healthcare applications.

C. Human Factors and User Acceptance

The success of XAI in healthcare depends on acceptance and adoption by clinicians, patients, and other stakeholders. Ensuring that XAI systems are user-friendly, intuitive, and align with the cognitive abilities of end-users is crucial. Addressing human factors, such as trust, perception, and usability, is essential for the effective integration of XAI into healthcare workflows.

D. Data Quality and Bias

The quality and bias present in healthcare data can affect the interpretability and fairness of AI models. Biases in data can lead to biased predictions and explanations, exacerbating healthcare disparities. Data preprocessing techniques and strategies for addressing bias and ensuring fairness in AI models need to be developed and implemented to enhance the reliability and trustworthiness of XAI in healthcare [19-20].

VIII. FUTURE DIRECTIONS

A. *Interpretable Deep Learning Model (IDLM):* Interpretable Deep Learning Model although highly accurate, is often considered a black box. Advancing research on interpretable deep learning models is crucial to enable both accuracy and transparency in healthcare AI. Developing techniques such as attention mechanisms, layer-wise relevance propagation, and concept activation vectors can enhance the interpretability of deep learning models.

B. Integration of XAI into Clinical Workflows

To ensure the seamless adoption of XAI in healthcare, it is essential to integrate XAI into clinical workflows and decision-making processes. XAI should be seamlessly integrated into electronic health records, clinical decision support systems, and other healthcare technologies to provide real-time explanations and support clinical decision-making.

C. Standardization and Regulatory Guidelines

Establishing standardized guidelines and regulatory frameworks for XAI in healthcare is necessary to ensure ethical and accountable use. These guidelines should address issues such as data privacy, security, bias mitigation, and transparency requirements. Collaboration among researchers, healthcare organizations, and regulatory bodies is essential to develop comprehensive guidelines.

C. Collaborative Approaches for XAI in Healthcare:

Collaboration among multidisciplinary teams, including clinicians, data scientists, and ethicists, is crucial for advancing XAI in healthcare. By fostering interdisciplinary collaboration, healthcare organizations can leverage diverse perspectives and expertise to develop effective, user-centric, and ethically sound XAI solutions that meet the needs of healthcare stakeholders [21-27].

IX. CONCLUSION

Explainable AI has the potential to address the challenges of transparency, trust, and regulatory compliance in healthcare AI systems. By providing interpretable explanations, XAI can enhance clinical decision-making, improve patient outcomes, and facilitate collaboration between clinicians and AI algorithms. However, there are challenges to overcome, such as complexity, interpretability-accuracy trade-offs, human factors, and data quality issues. Addressing these challenges and advancing research in XAI will pave the way for the responsible and effective integration of AI in healthcare, leading to improved patient care and outcomes. This paper has shown only the indication of the research that needs to carry out broadly. According to the White House draft report of 2020 for the regulation of AI applications one of the top concerns regarding Public trust in AI. Moreover, safety and security, fairness and public participation are major considerations for AI deployment in the healthcare sector.

REFERENCES

[1] Hamamoto, R. (2021). Application of artificial intelligence for medical research. In *Biomolecules* (Vol. 11, Issue 1, pp. 1–4). MDPI. https://doi.org/10.3390/biom11010090

[2] Anton, N., Doroftei, B., Curteanu, S., Catãlin, L., Ilie, O. D., Târcoveanu, F., & Bogdănici, C. M. (2023). Comprehensive Review on the Use of Artificial Intelligence in Ophthalmology and Future Research Directions. In *Diagnostics* (Vol. 13, Issue 1). MDPI. https://doi.org/10.3390/diagnostics13010100

[3] Hicks, S. A., Strümke, I., Thambawita, V., Hammou, M., Riegler, M. A., Halvorsen, P., & Parasa, S. (2022). On evaluation metrics for medical applications of artificial intelligence. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-09954-8

[4] Car, L. T., Dhinagaran, D. A., Kyaw, B. M., Kowatsch, T., Joty, S., Theng, Y. L., & Atun, R. (2020). Conversational agents in health care: Scoping review and conceptual analysis. In *Journal of Medical Internet Research* (Vol. 22, Issue 8). JMIR Publications Inc. https://doi.org/10.2196/17158

[5] le Glaz, A., Haralambous, Y., Kim-Dufor, D. H., Lenca, P., Billot, R., Ryan, T. C., Marsh, J., DeVylder, J., Walter, M., Berrouiguet, S., & Lemey, C. (2021). Machine learning and natural language processing in mental health: Systematic review. In *Journal of Medical Internet Research* (Vol. 23, Issue 5). JMIR Publications Inc. https://doi.org/10.2196/15708

[6] Laptev, V. A., Ershova, I. V., & Feyzrakhmanova, D. R. (2022). Medical Applications of Artificial Intelligence (Legal Aspects and Future Prospects). *Laws*, *11*(1). https://doi.org/10.3390/laws11010003

[7] Guo, Y., Hao, Z., Zhao, S., Gong, J., & Yang, F. (2020). Artificial intelligence in health care: Bibliometric analysis. *Journal of Medical Internet Research*, *22*(7). https://doi.org/10.2196/18228

[8] Alami, H., Lehoux, P., Auclair, Y., de Guise, M., Gagnon, M. P., Shaw, J., Roy, D., Fleet, R., Ahmed, M. A. A., & Fortin, J. P. (2020). Artificial intelligence and health technology assessment: Anticipating a new level of complexity. In *Journal of Medical Internet Research* (Vol. 22, Issue 7). JMIR Publications Inc. https://doi.org/10.2196/17707

[9] Sharma, M., Savage, C., Nair, M., Larsson, I., Svedberg, P., & Nygren, J. M. (2022). Artificial Intelligence Applications in Health Care Practice: Scoping Review. In *Journal of Medical Internet Research* (Vol. 24, Issue 10). JMIR Publications Inc. https://doi.org/10.2196/40238

[10] Ma, X., Niu, Y., Gu, L., Wang, Y., Zhao, Y., Bailey, J., & Lu, F. (2021). Understanding adversarial attacks on deep learning based medical image analysis systems. *Pattern Recognition*, *110*. https://doi.org/10.1016/j.patcog.2020.107332

[11] Ward, A., Sarraju, A., Chung, S., Li, J., Harrington, R., Heidenreich, P., Palaniappan, L., Scheinker, D., & Rodriguez, F. (2020). Machine learning and atherosclerotic cardiovascular disease risk prediction in a multi-ethnic population. *Npj Digital Medicine*, *3*(1). https://doi.org/10.1038/s41746-020-00331-1

[12] Li, W., Song, Y., Chen, K., Ying, J., Zheng, Z., Qiao, S., Yang, M., Zhang, M., & Zhang, Y. (2021). Predictive model and risk analysis for diabetic retinopathy using machine learning: A retrospective cohort study in China. *BMJ Open*, *11*(11). https://doi.org/10.1136/bmjopen-2021-050989

[13] Dosilovi6, F. K., Brci6, M., & Hlupi6, N. (n.d.). *Explainable Artificial Intelligence: A Survey*.

[14] Bharati, S., Mondal, M. R. H., & Podder, P. (2023). A Review on Explainable Artificial Intelligence for Healthcare: Why, How, and When? *IEEE Transactions on Artificial Intelligence*. https://doi.org/10.1109/TAI.2023.3266418

[15] Amann, J., Blasimme, A., Vayena, E., Frey, D., & Madai, V. I. (2020). Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. *BMC Medical Informatics and Decision Making*, *20*(1). https://doi.org/10.1186/s12911-020-01332-6

[16] Hasan Sapci, A., & Aylin Sapci, H. (2020). Artificial intelligence education and tools for medical and health informatics students: Systematic review. In *JMIR Medical Education* (Vol. 6, Issue 1). JMIR Publications Inc. https://doi.org/10.2196/19285

[17] Nithesh Naik, B. M. Zeeshan Hameed. et. al. (2022). Legal and Ethical Consideration in Artificial Intelligence in Healthcare: Who Takes Responsibility? Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8963864/

[18] Salman, M., Ahmed, A. W., Khan, A., Raza, B., & Latif, K. (2017). Artificial Intelligence in Bio-Medical Domain An Overview of AI Based Innovations in Medical. In *IJACSA) International Journal of Advanced Computer Science and Applications* (Vol. 8, Issue 8). www.ijacsa.thesai.org

[19] Rundo, L., Tangherloni, A., & Militello, C. (2022). Artificial Intelligence Applied to Medical Imaging and Computational Biology. In *Applied Sciences (Switzerland)* (Vol. 12, Issue 18). MDPI. https://doi.org/10.3390/app12189052

[20] Choudhury, N., & Begum, S. A. (2016). A Survey on Case-based Reasoning in Medicine. In *IJACSA) International Journal of Advanced Computer Science and Applications* (Vol. 7, Issue 8). www.ijacsa.thesai.org

[21] Gerke, S., Minssen, T., & Cohen, G. (2020). Ethical and legal challenges of artificial intelligence-driven healthcare. In *Artificial Intelligence in Healthcare* (pp. 295–336). Elsevier. https://doi.org/10.1016/B978-0-12-818438-7.00012-5

[22] Bhattad, P. B., & Jain, V. (2020). Artificial Intelligence in Modern Medicine – The Evolving Necessity of the Present and Role in Transforming the Future of Medical Care. *Cureus*. https://doi.org/10.7759/cureus.8041

[23] Alam, M. N., Singh, V., Kaur, M. R., Kabir, M. S. (2023). Big Data: An overview with Legal Aspects and Future Prospects. In *Journal of Emeging Technologies and Innovative Research (Vol. 10, Issue 5).* https://www.jetir.org/papers/JETIR2305670.pdf

[24] Alam, M. N., Kaur, B., & Kabir, M. S. (1994). Tracing the Historical Progression and Analyzing the Broader Implications of IoT: Opportunities and Challenges with Two Case Studies. *networks (eg, 4G, 5G)*, *7*, 8.

[25] Mohammad Nazmul Alam,Kulwinder Kaur,Md. Shahin Kabir,Naznin Huda Susmi,Sohrab Hossain, "UNCOVERING CONSUMER SENTIMENTS AND DINING PREFERENCES: A LEGAL AND ETHICAL CONSIDERATION TO MACHINE LEARNING-BASED SENTIMENT ANALYSIS OF ONLINE RESTAURANT REVIEWS", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Volume.11, Issue 5, pp.b834-b839, May 2023, Available at :http://www.ijcrt.org/papers/IJCRT2305239.pdf

[26] Kabir, M. S., & Alam, M. N. (2023). IoT, Big Data and AI Applications in the Law Enforcement and Legal System: A Review.

[27] Guo, J., & Li, B. (2018). The Application of Medical Artificial Intelligence Technology in Rural Areas of Developing Countries. In *Health Equity* (Vol. 2, Issue 1, pp. 174–181). Mary Ann Liebert Inc. https://doi.org/10.1089/heq.2018.0037