Clinical Case Reports and Studies
2024 Volume 5, Issue 6
DOI: 10.59657/2837-2565.brs.24.130

BioRes Scientia
Value your Research

Review article

Open Access

Machine Learning and Deep Learning Based Healthcare System: A Review

Ashish Kumar*, Jagdeep Kaur

Department of Computer Science and Engineering, Lovely Professional University, Punjab, India.

**Corresponding author: Ashish Kumar.*

Abstract

The way medical data is evaluated, diagnoses are made, and patient care is provided has all changed dramatically as a result of the integration of machine learning (ML) and deep learning (DL) techniques in healthcare systems. An overview of the developments and uses of ML and DL in healthcare is provided in this study, with a focus on how they might enhance productivity, accuracy, and individualized care. The healthcare sector produces enormous volumes of data, which include patient-generated data, genetic information, electronic health records (EHRs), and medical photographs.ML algorithms have proven to be adept at managing this heterogeneous set of data by revealing patterns that were previously unknown, forecasting results, and offering insightful analysis. Furthermore, DL, a subset of ML, has demonstrated remarkable performance in voice and picture recognition tasks, which makes it a perfect fit for applications like natural language processing in healthcare and medical image analysis. Large dataset training algorithms can help medical practitioners detect illnesses early on, frequently before symptoms appear. Both patient outcomes and healthcare expenses can be greatly improved by this early identification. Furthermore, ML models can forecast the course of a disease and suggest individualized treatment strategies based on the unique characteristics of each patient. Medical imaging is a further field in which DL has shown impressive results. Tasks including tumor diagnosis, organ segmentation, and disease identification have been surpassed by Convolutional Neural Networks (CNNs) and other DL architectures over standard image analysis techniques. The use of deep learning (DL) in diagnostic imaging systems has resulted in improved precision and expedited interpretation of medical images, hence expediting diagnosis and treatment determinations. This paper proposes a comprehensive methodological framework to analyze and examine the heterogeneous data and better understand the relationship between depression and quality of life components using machine learning and deep learning techniques. To further validate the posterior probability multi-class Support Vector Machine's performance, the classification issues were extracted from the clustered data, and the self-organizing map produced a 08-cluster solution. Classification accuracy was 91.16% when the suggested model was used, which improved classification performance.

Keywords: ML; DL; healthcare; quality of life

Introduction

It is somewhat challenging to transport patients in the modern world from their homes to hospitals for routine checkups. There are several difficulties, such as long wait times, travel times, and the possibility of multiple diseases for patients going through this contaminated area. Thus, in-home health care services—which allow patients to receive medical examinations in the convenience of their own homes—are the focus of the health care sector. A remote health monitoring system facilitates patient consultation with physicians in urban regions for those living in distant places. Smart, effective, and safe healthcare systems are being created as a top global priority to improve people's quality of life. An early study of human behavior has drawn scientists from a variety of professions to the realms of neuroscience and psychology. The expanding fields of computer science, machine learning, and deep learning research are similar in this regard. Recognizing a patient's mental health problems is a persistent problem for medical professionals and institutions, and it is not a novel occurrence, particularly in the younger demographic. Current developments in the fields of deep learning and machine learning have demonstrated the ability to both diagnose psychiatric problems in individuals and recognize how these diseases affect their way of life. Machine learning approaches are also yielding advancements in many other fields, such as multi-omics illness discovery and the detection of human activity as a predictor of suicidal behavior. Recent instances have demonstrated how deep learning and machine learning are assisting in the creation of algorithms that can function just as well as human doctors. Machine learning is doing a great job in the healthcare industry by identifying patterns in data and pictures, which aids medical professionals and organizations in the detection of several fatal diseases. Artificial intelligence has been transformed by deep learning, which has been used in several healthcare domains like signal processing, image processing, and natural

language processing. Specifically, the use of Bayesian deep learning in healthcare has been explored; these include applications in electronic health records, clinical signal processing, medical natural language processing, and medical imaging tasks. Neural network structures, such as ResNetv2 and GPT-3, with an input layer, an output layer, and several hidden layers (ranging from two to tens or hundreds of layers with millions or even billions of parameters) are used in the machine learning subfield of deep learning. The healthcare industry has seen significant advancements in the extraction of usable information from data and the availability of massive amounts of data. These developments have allowed for the application of DL in numerous subfields, including medical imaging, where it has been shown to exceed human expertise. These models can handle multiple different types of inputs at once and generate multiple types of output in complex models. They can take different types of data as input, such as images, text, and health records, and produce various types of output, such as generating images, predicting classes, and analyzing text. Deep learning techniques have been thoroughly studied in pharmaceuticals, drug discovery, and illness diagnostics in addition to medical imaging.

Literature Review

Here, the authors surveyed a few papers related to healthcare using machine learning (ML) and deep learning (DL) applications in health systems revealing a rapidly evolving field with promising advancements. Here's an overview of key themes and findings from relevant studies up to my last knowledge update as given in Table 1.

Table 1: Literature Review of Healthcare

Year	Title	Techniques	Objective	Limitations
2022	Machine Learning Based Healthcare System for Investigating the Association Between Depression and Quality of Life	ANN, SVM	Prioritise patient-centered outcomes as the primary metrics for assessing the effectiveness of the machine learning-based healthcare system. These goals should include better mental health, higher patient happiness, and improved quality of life.	Over time, both health problems and the link between depression and quality of life may change. The model might not take temporal changes into account, and it could require regular revisions to be accurate.
2020	Machine Learning-based Health Monitoring System	SVM	Create machine learning models that can examine a variety of health metrics and data patterns to identify early indicators of anomalies or health problems.	Biases in the training set of data may be inherited by machine learning models. To prevent discrepancies in care, it is imperative to ensure fairness and overcome biases in forecasts, particularly in the healthcare industry.
2022	Significance of machine learning in healthcare: Features, pillars and applications	SVM KNN LSTM	Provide machine learning-based real-time health monitoring systems that enable ongoing surveillance of health indicators and vital signs for preventive care.	It might be difficult to comply with data privacy rules and navigate healthcare regulations.
2022	A Review on Bayesian Deep Learning in Healthcare: Applications and Challenges	ANN CNN Bayesian Deep Learning	Analyze the effects of using Bayesian Deep Learning in settings involving healthcare data, addressing issues with data security and privacy and suggesting ways to guarantee adherence to legal requirements.	Bayesian techniques can be computationally costly, particularly when used in deep learning applications. The time and resources needed for model training and inference, which might be crucial in real-time healthcare applications, maybe a problem due to its complexity.
2023	Applications of Deep Learning for Disease Management	CNN RNN DNN	Patients and healthcare professionals may find it challenging to understand the judgments made by deep learning models due to their frequent lack of transparency.	By using deep learning models to stratify patients according to their risk profiles, medical professionals may better target therapies for those who are more likely to have problems or disease progression.
2020	Deep Learning for Multigrade Brain Tumor Classification in Smart Healthcare Systems: A Prospective Survey	CNN ResNet AlexNet VGGNet Transfer learning	Analyze how well deep learning models diagnose brain tumors in various grades, taking into account variables like overall accuracy, sensitivity, and specificity for each tumor grade.	Biases in the training set, such as differences in picture-gathering techniques and demographic biases, might affect how well the examined models perform and how broadly they can be applied.

Research Objectives

Q1: What is the role of Machine learning and deep learning in healthcare?
Q2: To what extent can machine learning be utilized in healthcare fraud detection?
Q3: How can deep learning models be leveraged for personalized medicine, including tailoring treatment plans based on individual patient characteristics, genetic information, and response to previous interventions?
Q4: To identify and discuss the significant applications of ML and DL in healthcare.

Findings

Research Questions are answered in this section.

Q1: What is the role of Machine learning and deep learning in healthcare?

To anticipate illness risks and categorize people according to their propensity to acquire particular ailments, machine learning models analyze patient data from medical pictures. This helps with the early identification and diagnosis of diseases based on patterns in X-rays, MRIs, CT scans, etc. It offers suggestions based on research to help medical practitioners make well-informed choices regarding patient care. Because of DL's proficiency in image recognition tasks, complicated medical pictures may be interpreted more accurately and automatically. It improves the accuracy of diagnosis and treatment planning by managing complicated and high-dimensional data, enhancing the capabilities of clinical decision support systems.

Q2: To what extent can machine learning be utilized in healthcare fraud detection?

Healthcare fraud detection may be greatly enhanced by machine learning (ML), which provides a variety of methods for spotting irregularities, trends, and questionable activity in healthcare systems. By using previous fraud data, machine learning models may create prediction models that allow for the real-time identification of possible fraudulent situations. These algorithms estimate the risk of fraud using information including patient demographics, provider histories, and billing codes. It may be used, together with graph-based algorithms, to examine the connections between healthcare entities, including insurers, patients, and providers. Abnormal connections or patterns inside a network might point to fraud.

Q3: How can deep learning models be leveraged for personalized medicine, including tailoring treatment plans based on individual patient characteristics, genetic information, and response to previous interventions?

Personalized dosage recommendations based on hereditary characteristics and the discovery of appropriate drug candidates are made possible by deep learning algorithms that analyze molecular structures and pharmacogenomic data to predict individual reactions to drugs. It processes a variety of patient data, such as genetic data, electronic health records, and lifestyle variables, to stratify people according to their propensity to acquire particular disorders and forecast disease risks.

Q4: To identify and discuss the significant applications of ML and DL in healthcare.

The application of ML and DL is given in Table2

Table 2: Application of ML and DL

ML	DL
Using characteristics including genetic information, medical history, and lifestyle choices to predict illness risks and stratify patients according to their propensity to acquire particular disorders.	Finding more precise illness predictions through the analysis of complicated patterns in high-dimensional data, particularly when the correlations are complex and nonlinear.
automated image interpretation that recognizes trends and anomalies in X-ray, CT, and MRI images.	Deep learning performs exceptionally well in picture identification tasks, improving diagnosis accuracy by automatically identifying minute patterns suggestive of illnesses.
using genetic data analysis to customize treatment programs and forecast medication reactions based on unique genomic profiles.	identifying genetic markers linked to illnesses and treatment outcomes more precisely by revealing complex linkages in genomic data.
using chemical and biological data to predict drug candidates, optimize clinical trial designs, and pinpoint possible medication interactions.	large-scale biological information for analysis to find new targets and biomarkers quickly in the drug discovery process.

Challenges

Challenges in Healthcare using Machine Learning

- Frequently, healthcare data is dispersed, non-uniform, and kept in diverse formats over several platforms. For ML applications, ensuring data accessibility and quality can be a major challenge.
- Interoperability problems arise from the disparate technology and standards used by healthcare systems. Without standardized interfaces, it is difficult to integrate ML models into various healthcare IT systems.
- Because the healthcare industry is heavily regulated, machine learning applications need to adhere to several rules. It might take a while to get regulatory approval for some machine learning applications, particularly those used in diagnosis and treatment.

Challenges in Healthcare using Deep Learning

- Sensitive healthcare data necessitates tight privacy restrictions for deep learning models trained on it. It is essential to guarantee patient information security both during training and deployment.
- It can be difficult to incorporate deep learning models into current healthcare workflows. Adopting new technology that complicates daily tasks or upends existing processes may be met with resistance from the healthcare industry.
- Unbalanced datasets might result from unusual circumstances in the healthcare industry. The inability of deep learning models to learn from unusual examples may affect their capacity to identify and forecast uncommon conditions.

Conclusion

The number of papers comprised in this review was 20 in total from the analysis of these papers. Using ML and DL techniques to Identification of mental problems is considered a challenge to doctors and healthcare organizations. For any physician, scientist, or researcher, machine learning (ML) may be a very useful tool. It seems like a machine learning breakthrough occurs every day. Every advancement brings forth a fresh machine-learning application capable of resolving a real-world healthcare issue. The medical field is closely monitoring this trend as machine learning continues to progress. Concepts from machine learning (ML) are helping physicians and surgeons save more lives, identify illnesses and issues before they arise, improve patient care, include patients more effectively in their recuperation, and much more. Global companies use ML models and AI-driven technologies to enhance healthcare delivery. Health organizations understand that treating the full person—including lifestyle and environment—is necessary to promote overall health. Machine learning techniques, such as Linear Regression Multi-Variate, based on error analysis, can identify people at a higher risk of acquiring avoidable chronic illnesses, such as diabetes, heart disease, etc.SVM with RF Classifier to yield optimal outcomes. This method will thus aid in maintaining health. Convolutional Neural Networks (CNNs) are one type of deep learning model that is used for tasks like pathology slides, CT scans, MRIs, and X-ray abnormality detection.

References

1. Habib, Masood, et al. (2022). Machine learning based healthcare system for investigating the association between depression and quality of life. *IEEE Journal of Biomedical and Health Informatics,* 26(5).
2. Javaid, Mohd, et al. (2022). Significance of machine learning in healthcare: Features, pillars, and applications. *International Journal of Intelligent Networks,* 3
3. Bundi, Doreen Nkirote. (2023). Adoption of machine learning systems within the health sector: a systematic review, synthesis and research agenda. *Digital Transformation and Society*.
4. Sheela, K. Gnana, and Anu Rose Varghese. (2020). Machine learning-based health monitoring system. *Materials Today: Proceedings*, 24.
5. Abdullah, Abdullah A., Masoud M. Hassan, and Yaseen T. Mustafa. (2022). A review on Bayesian deep learning in healthcare: Applications and challenges. *IEEE Access* 10.
6. Yadav, Rashmi, and Aruna Bhat. (2022). Applications of Deep Learning for Disease Management. 2022 4th International Conference on Advances in Computing, Communication Control and Networking (ICAC3N). IEEE.
7. Muhammad, Khan, et al. (2020). Deep learning for multigrade brain tumor classification in smart healthcare systems: A prospective survey. *IEEE*

Transactions on Neural Networks and Learning Systems, 32(2).
8. Shickel, Benjamin, et al. (2017). Deep EHR: a survey of recent advances in deep learning techniques for electronic health record (EHR) analysis. IEEE journal of biomedical and health informatics 22(5).
9. Iqbal, Saqib, et al. (2021). Prostate cancer detection using deep learning and traditional techniques. *IEEE Access*, 9.
10. Passos, Ives Cavalcante, et al. (2019). Big data and machine learning meet the health sciences. Personalized psychiatry: big data analytics in mental health.
11. Shatte, Adrian BR, Delyse M. Hutchinson, and Samantha J. (2019). Teague. Machine learning in mental health: a scoping review of methods and applications. *Psychological Medicine,* 49(9).
12. Tucker, Allan, et al. (2020). Generating high-fidelity synthetic patient data for assessing machine learning healthcare software. *NPJ digital medicine,* 3(1).
13. Kaur, Prableen, Manik Sharma, and Mamta Mittal. (2018). Big data and machine learning based secure healthcare framework. *Procedia computer science*, 132.
14. Bhardwaj, Rohan, Ankita R. Nambiar, and Debojyoti Dutta. (2017). A study of machine learning in healthcare. 2017 IEEE 41st annual computer software and applications conference (COMPSAC). *IEEE,* 2.
15. Li, Jian Ping, et al. (2020). Heart disease identification method using machine learning classification in e-healthcare. *IEEE*, 8
16. Ahmed, Zeeshan, et al. (2020). Artificial intelligence with multi-functional machine learning platform development for better healthcare and precision medicine.
17. Roth, Jan A., et al. (2018). Introduction to machine learning in digital healthcare epidemiology. Infection Control & Hospital Epidemiology 39(12).
18. Li, Jian Ping, et al. (2020). Heart disease identification method using machine learning classification in e-healthcare. *IEEE*, 8.

Cite this article: Kumar A, Kaur J. (2024). Machine Learning and Deep Learning Based Healthcare System: A Review. *Clinical Case Reports & Studies,* BioRes Scientia Publishers. 5(6):1-5. DOI: 10.59657/2837-2565.brs.24.130

Article History: **Received:** April 22, 2024 | **Accepted:** May 06, 2024 | **Published:** May 17, 2024