

Disease Prognosis Using Artificial Intelligence Neural Networks

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Abstract

The proactive anticipation of disease occurrence stands as a pivotal facet within healthcare and medical research endeavors, dedicated to forecasting the probability of an individual manifesting a particular medical condition or ailment in the future. This fundamental pursuit integrates diverse data reservoirs, encompassing medical history, genetic profiles, lifestyle determinants, and emerging technological advancements, to construct predictive frameworks capable of furnishing early indications and insights pertaining to potential health vulnerabilities. The overarching aim of disease prediction resides in furnishing healthcare practitioners and individuals alike with the requisite knowledge and resources to undertake pre-emptive measures, render informed choices, and ultimately enhance holistic health and well-being. The Neural Network algorithm emerges as a dependable approach for disease prognostication, offering heightened precision and several advantages compared to the conventional methodologies, including its capacity to discern intricate features from images and its adaptability across diverse computing platforms. The proposed study offers a comprehensive review of disease prediction methods, comparing conventional approaches with machine learning interventions to provide swift and reliable results. Further review suggests a

proposed model that utilizes the neural network algorithms to overcome the shortcomings of conventional methods.

Keywords: Healthcare, Machine Learning, Disease Prediction, Artificial Intelligence

1. Introduction

The transformative potential of disease prediction in healthcare is evident in its ability to enable early intervention, enhance patient outcomes, and alleviate strain on healthcare systems. Such capabilities foster a proactive stance towards wellness and healthcare management. The aim of this project is to explore the evolving terrain of disease prediction, underscoring the significance of data-driven methodologies and their potential implications for public health. We will investigate the fundamental approaches, technological progressions, and ethical dilemmas inherent in disease prediction, assessing how this burgeoning domain stands to redefine healthcare. Emphasis will be placed on proactive prevention strategies and tailored patient care.

Healthcare relies significantly on disease prediction, employing data-driven techniques and advanced technologies to foresee and diagnose potential health concerns prior to clinical manifestation. Disease prediction integrates artificial intelligence, machine learning, and comprehensive analysis of health data to bolster early detection, prevention, and intervention endeavors. Through the examination of varied patient datasets encompassing genetic markers, lifestyle variables, and past medical histories, predictive models can gauge the probability of particular diseases

This proactive methodology not only fosters the creation of tailored preventive measures by healthcare professionals but also streamlines resource distribution, leading to enhanced healthcare results at a broader level.

The study discuss the use of the conventional methods, machine learning, and artificial intelligence in the disease prediction and states the limitations of the conventional method and suggests the use of neural network algorithms to improve the present scenario of disease detection

The rest of the manuscript is organized as follows: Section 2 presents the related study and provides a comparison based on the study. Section 3 introduces a suggested model, Section 4 includes the discussion, and Section 5 presents the conclusion.

2. Related Study

Noncommunicable diseases, particularly chronic diseases, stand as the predominant contributors to both physical and mental health decline globally, significantly contributing to morbidity and mortality rates. Although chronic diseases are largely preventable at certain stages, their prevalence underscores the importance of effective preventive measures. In this context, predictive models for disease play a pivotal role in aiding healthcare providers and patients in clinical decision-making processes. This study investigates the efficacy of the Stacking Classifier in assessing the performance of predictive models for chronic diseases. This proposed model demonstrates the highest F1-Score, achieving 98.84% on PIMA dataset, 98% post-validation on synthetic data, 97.3% on ADRC data, and 96.20% on FHD data. Comparative experiments conducted on PIMA dataset illustrate the superior performance of the proposed technique. Furthermore, the research elucidates the rationale behind the suggested model and undertakes an ethical evaluation concerning the interpretability of Machine Learning models in clinical settings. Considering evaluation metrics such as accuracy and F1-score, the authors assert that the proposed technique emerges as the optimal classification model when juxtaposed with alternative classification models [1].

The emergence of digital twin-based healthcare systems represents a compelling area of exploration with promising potential to improve the quality of life for elderly and disabled individuals who are residing in remote regions. With the proliferation of smart city initiatives and advancements in healthcare services accessible via smartphones, contemporary digital twin based healthcare system has garnered increased attention and interest from various stakeholders. Utilizing the Optimized Fuzzy-based k-Nearest Neighbor (OF-k-NN) classifier model, the proposed Digital Twin based Healthcare Systems (DTHS) are constructed on a cloud platform for the prediction of Parkinson's disease. It demonstrates superior performance compared to existing classifiers such as Neural Networks and Kernel-based Support Vector Machines (SVM) across several metrics. Specifically, the DTHS achieves a prediction accuracy of 97.95% for DS1 and 91.48% for DS2, with prediction times of 0.00127 seconds

for DS1 and 0.00105 seconds for DS2. Moreover, it attains F1-scores of 0.98 for DS1 & 0.91 for the DS2, along with Matthews Correlation Coefficients of 0.93675 for DS1 and 0.79816 for DS2, further underlining its efficacy and superiority in disease prediction [2].

Deep learning-based methodologies are increasingly being leveraged in medical informatics to forecast & diagnose cardiovascular disease (CVDs), offering insights into clinical symptoms, phenotype characterization, and treatment strategies for intricate diseases. Employing a vast dataset comprising patient medical records, a deep learning model was constructed to predict CVDs in this study. Specifically, deep learning based regression analysis was applied to a dataset encompassing 2621 medical records obtained from hospitals in the UAE, incorporating variables such as age, symptoms, and CVD-related information to facilitate early prediction of CVDs. Through regression analysis, the authors propose the utilization of a long short-term memory-based deep neural network for early prediction of CVDs. Notably, the accuracy of disease prediction is bolstered when considering pairs of diseases due to overlapping symptoms. The study's outcomes reveal that coronary heart disease can be predicted with 71.5% accuracy, exhibiting an 84.4% overlap with dyspnea. Furthermore, the authors substantiate the efficacy of the proposed methodology across various evaluation criteria [3].

Asymptomatic Chronic Kidney Disease (CKD) is widespread, yet guideline-directed monitoring for CKD prediction based on multiple indicators remains underutilized. Computer-aided automated diagnostics (CAD) present a valuable tool in forecasting CKD, with deep learning algorithms demonstrating excellent classification accuracy in disease diagnosis. This study advocates for the integration of the most effective DL models into the Internet of Medical Things (IoMT), aiming to enhance CKD prediction through more efficient and effective utilization of deep learning techniques. To address missing variables, the author employed multiple imputations (MI). This imputation method utilizes linear regression to predict continuous data and logistic regression to identify categorical variables. In the multiple imputations (MI) process, missing values within the dataset are replaced multiple times, typically with a small number (n). The authors selected a dataset with a mean and standard deviation closest to the original dataset's variables to narrow down the data subset to a plausible range of values [5].

Cardiovascular diseases stand as the most lethal conditions globally, bearing the highest mortality rates and placing significant strains on national healthcare systems. Over time, they have become increasingly prevalent, necessitating effectual early detection methods. Major risk factors for the cardiovascular disease include high blood pressure, a family history of cardiovascular disease, stress, age, gender, cholesterol levels, BMI, and an unhealthy lifestyle. Using these parameters, researchers have devised various methods for early detection. In the experiment, algorithms such as KNN and random forest were employed.

It was observed that KNN yielded a relatively higher accuracy rate (66.7%) compared to Random Forest (63.49%). Consequently, KNN was selected as the proposed algorithm. However, this selection significantly escalates computing complexity, rendering the solution impractical for real-world applications. Furthermore, authentic feature selection methods need enhancement to minimize computing complexity while maintaining acceptable accuracy levels [6].

Fog computing represents a novel computing paradigm offering latency-aware and highly adaptable services to geographically dispersed end-users. It boasts enhanced safety compared to cloud computing by swiftly storing and processing information nearer to data sources on local fog nodes. Concurrently, Blockchain (BC) technology has become a revolutionary innovation, emphasizing data security and anonymity while ensuring data validity through the consensus process. Its adoption spans various sectors, notably healthcare, where it facilitates secure healthcare services for disease prognosis in the fog computing. This research introduces an improved Blockchain based secured healthcare service for disease identification within fog computing. The proposed approach efficiently clusters and predicts diseases compared to alternative methods. Enhancing security and privacy concerning patient medical data access and incorporating hybrid clustering and classification models could further optimize prediction performance [7].

Chronic kidney disease (CKD) is a growing global concern, with asymptomatic cases being particularly prevalent. However, guideline-directed monitoring to anticipate CKD based on multiple variables remains underutilized. Computer-aided automated diagnostics (CAD) offer promising prospects in CKD forecasting, especially due to their outstanding classification accuracy, particularly deep learning algorithms. These models outperform conventional data

categorization methods, enhancing prediction capabilities significantly. To leverage the potential of deep learning further, the study proposes integrating high-performing DL models into the Internet of Medical Things (IoMT), thus improving predictive analytics for CKD. To address missing values in the dataset, multiple imputations (MI) were conducted. The imputation process utilized linear regression for continuous variables and logistic regression for categorical variables. Missing values were replaced multiple times, typically with a small number (n) of iterations. Through 10 iterations of MI, 10 different datasets were generated. The dataset chosen for further analysis closely matched the original dataset in terms of means and standard deviations, ensuring a subset with a plausible range of values [9].

Machine learning (ML) and data mining (DM) techniques play a crucial role in healthcare systems, effectively converting available data into actionable knowledge. Literature suggests a 12% error rate in disease diagnosis by medical practitioners, highlighting the need for more accurate predictive models. Additionally, many existing models fail to utilize Area under Curve (AUC), a critical evaluation metric, particularly in medical datasets where accuracy alone may not suffice for robust disease risk prediction. Moreover, the absence of consideration for algorithm runtime poses a significant limitation in previous prediction models. While improvements in prediction accuracy are necessary, it's evident in the way that many models overlook key aspects such as feature reduction and the utilization of AUC, essential for robust disease risk prediction and assessing ML algorithm performance in healthcare datasets. Furthermore, the issue of imbalanced datasets, as observed in the Switzerland heart dataset, can lead to misleading predictions and warrants attention. Addressing these limitations presents opportunities for enhancing the effectiveness and reliability of predictive models in healthcare applications [12].

Extensive research in healthcare big data analysis has explored various applications such as intelligent negotiation, disease diagnosis, question-answering doctors, and medical decision support systems, yielding substantial achievements. The widespread adoption of electronic medical information, including electronic medical records (EMR), online appointments, and reports, has led to the accumulation of large-scale healthcare data worldwide. In addressing the limitations of existing models, our proposed medical history-based disease prediction algorithm combines the strengths of Factorization Machines (FM) and Deep Neural Networks (DNN). This approach overcomes the shortcomings of previous models

by effectively handling high-order relations among disease features and considering the low-order combinations that contribute to specific diseases, thereby enhancing the model's comprehensiveness. Significant experiments have been conducted using real-world datasets to predict potential phenotypes based on observed gene phenotypes. These experiments demonstrate the efficacy of our proposed algorithm in predicting potential diseases accurately and efficiently [13].

Liver disorders encompass a spectrum of conditions requiring clinical attention from healthcare professionals. In this study, the authors present a classification model to accurately diagnose liver disorders using various data mining algorithms. The dataset consists of 416 clinical records of liver disorder patients and 167 clinical records of non-liver disorder patients, collected from the North Eastern Areas of India. The "Field" attribute serves as a category label, distinguishing between the liver disorder patients and the non-liver disorder patients. Upon analysis, we implemented several data mining algorithms, including Random Forest, K-Means, and KNN. Our findings demonstrate that the Random Forest algorithm, when applied without modifications, yielded higher accuracy compared to other algorithms discussed in the related work section. Notably, the K-Means algorithm achieved the maximum precision, while the KNN Algorithm demonstrated the maximum recall [15].

Table 1. Comparative Study

	Authors	Title	Year	Methodology	Demerits
[1]	Pooja Yadhav, S.C. Sharma, Shashikant P. Patole, Rajesh Mahadeva	Examining Hyperparameters and Feature Selection Methods for Anticipating Non-Communicable Chronic Diseases with a Stacking Classifier	2023	Synthetic Minority Over-Sampling Technique (SMOTE) algorithm	Use Of Electronic Health Record (EHR) data raises concerns about data privacy and compliance with regulations like HIPAA

[2]	L. Abirami, J. Karthikeyan	A Digital Twin-Based Healthcare System (DTHS) for Early Parkinson's Disease Detection and Diagnosis Through an Optimized Fuzzy-Based K-Nearest Neighbor Classifier Model	2023	Digital Twin based Healthcare System (DTHS)	Implementing the proposed DTHS in real Clinical Settings, where factors like data integration with EHR, physician adoption are crucial
[3]	Sara Ghorashi, Anam Riaz, Khunsa Rehman, H.K. Alkahtani, Amna Parveen, Ahmed H. Samak	Utilizing Regression Analysis for Anticipating Concurrent Symptoms of Cardiovascular Diseases	2023	A Long Short-Term Memory-based Deep Neural Network	Primarily focuses on accuracy levels when simulating overlapping symptoms
[5]	Vijay Panwar, Naved Choudhary, Sonam Mittal, Gaurav Sahu	Streamlined Medical Diagnosis of Human Heart Diseases through Machine Learning Techniques with and without GridSearchCV	2022	ML algorithms such as LR, KNN, SVM, and GBC with GridSearchCV	Doesn't provide a detailed comparison with other existing heart disease prediction models
[6]	A. Rahim, Y. Rasheed, F. Azam, M.W. Anwar, M.U. Rahim, Abdul W. Muzaffar	A Unified Machine Learning Framework for Enhanced Prediction of Cardiovascular Diseases	2021	A MaLCaDD (Machine Learning based Cardiovascular Disease Diagnosis) framework	Dealing with missing values, data imbalance using mean replacement and SMOTE may oversimplify the complexities of medical data
[7]	P.G. Shynu, Varun G.Menon, R.L. Kumar, Yunyoung Nam	Blockchain enabled Secure Healthcare Application for Diabetic-Cardio Disease Prediction in Fog Computing Environment	2021	An Efficient Block chain-based secure healthcare services	Limited scalability by the capacity of the block chain network, healthcare transactions and data storage

[9]	S. Akter, Ahsan Habib, MD. Ashiqul Islam, W.A. Fahim, Manik Ahmed	Thorough Evaluation of Deep Learning Models for Early Prediction and Risk Identification of Chronic Kidney Disease	2021	A Novel Approach using Seven State-of-the-Art DL Algorithms	Does not discuss the practicality of running these models in real-time clinical settings, low-latency decision
[12]	Syed J. Pasha, E. Syed Mohamed	Innovative Feature Reduction Model Integrating Machine Learning and Data Mining Algorithms for Enhanced Disease Risk Prediction	2020	A Novel Feature Reduction (NFR) model aligned with ML and DM algorithms	Does not provide a detailed comparison with these existing methods, challenging to assess the extent of improvement
[13]	W. Hong, Z. Xiong, Nannan Zheng, Y. Weng	A Medical History-Driven Algorithm for Disease Prediction	2019	A Novel Deep Learning-based Hybrid Recommendation algorithm	Have to overlook important data sources, like genetic information or recent diagnostic tests
[15]	Sanjay Kumar, Sarthak Katyal	Efficient Analysis and Diagnosis of Liver Disorders through Data Mining	2018	K-Means Algorithm and KNN Algorithm	Didn't mention whether the models were validated on an independent dataset or if cross-validation was performed

3. Proposed System

Modern healthcare has witnessed a significant evolution in disease prediction, propelled by advanced technologies and data-driven methodologies. By harnessing extensive health-related data such as electronic health records, genetic profiles, lifestyle choices, and environmental factors, predictive models now excel at identifying patterns and risk indicators.

These insights empower healthcare professionals, researchers, and individuals to make informed decisions regarding disease prevention and management. In our proposed approach, users can access diagnostic and treatment information related to diseases by inputting symptoms into a search engine. The system preprocesses the symptoms to extract keywords, streamlining the diagnosis process. To forecast disease occurrence, we employ a linear regression technique. This method utilizes a medical dataset as input to predict the presence or absence of specific conditions.

Through extensive training on a comprehensive dataset and disease labels, our system incorporates features derived from medical images to train a Neural Network model. This model learns to recognize patterns associated with various diseases, enabling accurate forecasts of disease likelihood.

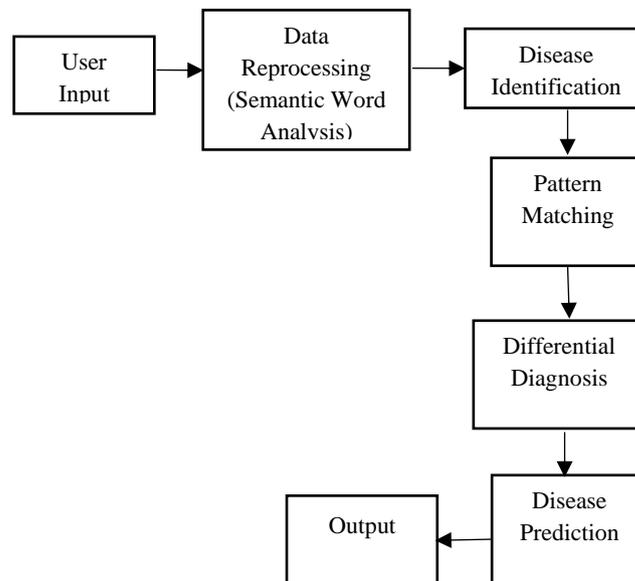


Figure 1. Block Diagram

3.1 User Input

This component represents the interface through which users interact with the system. Users provide input data, which typically includes symptoms, medical history, and possibly other relevant information.

3.2 Data Reprocessing (Semantic Word Analysis)

This component involves the processing and analysis of the input data using semantic word analysis techniques. Semantic word analysis aims to extract meaningful insights from textual data, such as medical reports or descriptions of symptoms, by understanding the contextual meaning of words and phrases.

3.3 Disease Identification

After the data is preprocessed and analyzed, this component aims to identify potential diseases or health conditions based on the extracted information. It utilizes algorithms and rules to match the input data with known symptoms and disease patterns.

3.4 Pattern Matching

Pattern matching involves comparing the symptoms and characteristics of the input data with patterns stored in the system's database or knowledge base. It helps to identify similarities between the input data and known disease patterns, facilitating accurate disease recognition.

3.5 Differential Diagnosis

This component is responsible for narrowing down potential diseases or conditions by conducting a process known as differential diagnosis. It involves systematically comparing and contrasting the symptoms and characteristics of different diseases to determine the most likely diagnosis.

3.6 Disease Prediction

Disease prediction utilizes linear regression techniques to forecast the likelihood of specific diseases or health outcomes based on the input data and historical patterns. Linear regression models analyze the relationship between independent variables (e.g., symptoms, risk factors) and dependent variables (e.g., disease occurrence) to make predictions.

4. Discussion

The existing system of Computer-Aided Diagnosis (CAD) has made significant strides in leveraging Machine Learning (ML) for disease identification, yet it faces limitations.

Conventional equations struggle to accurately discern complex bodily entities, necessitating extensive real-life training data for effective pattern recognition. While ML methodologies promise unbiased decision-making, the current system may lack scalability and may not fully exploit the wealth of available health data.

In contrast, the proposed system is suggested with the expectation to revolutionize disease prediction by integrating diverse data sources and employing advanced techniques like linear regression and Neural Network models. By preprocessing symptoms and incorporating medical image features, the proposed system enhances diagnostic accuracy and prediction capabilities. Unlike the existing system, it enables users to rapidly access diagnostic and treatment information through a search engine interface, facilitating informed decision-making in disease management. In future work the research would leap into the implementation and the performance evaluation of the proposed system with the appropriate dataset to train and test the model and to assess its performance on the improved scalability, accuracy, and accessibility it offers compared to the limitations of the existing CAD framework.

5. Conclusion

Disease prediction systems represent a pivotal advancement in healthcare, reshaping the industry by facilitating prior detection, personalized treatment strategies, optimized resource allocation, and accelerated research efforts. Leveraging cutting-edge technologies and data-driven methodologies, these systems excel at identifying patterns and risk factors associated with disease onset, thereby enabling timely interventions, enhancing patient outcomes, and curbing healthcare expenditures. Successful implementation of disease prediction systems necessitates meticulous attention to input and output design, rigorous system testing, and strategic deployment strategies to ensure reliability, accuracy, and efficacy in clinical settings. As these systems continually evolve and integrate more sophisticated machine learning techniques, their impact on healthcare will undoubtedly expand. They permit individuals to carefully direct their health, fostering a populace that is healthier and more resilient to disease. The study will proceed further with the implementation of the proposed model using an appropriate dataset, parameters, etc., followed by the evaluation of the model and its deployment for clinical diagnosis.

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