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Machine Learning in Healthcare: A Comparative Review of Techniques and Applications

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Abstract: ***The rise of machine learning has profoundly impacted healthcare, enhancing the interpretation and utilization of medical data. It emphasizes how machine learning may improve diagnosis accuracy, maximize treatment choices, and advance precision medicine. According to previous research, machine learning algorithms are highly accurate in disease diagnosis. But comprehensive information on algorithms accuracy is rarely available in a single study, making access time-consuming. So, the objective of this work is to provide necessary information about these algorithms used in healthcare and to review various applications of machine learning in healthcare including disease diagnosis, personalized medicine, medical imaging and patient monitoring. A comparative analysis of these approaches is conducted based on accuracy, across multiple healthcare applications including Breast Cancer, Heart Disease, Diabetes, COVID-19 and Glaucoma prediction from the literature and highlighting best algorithm for specific disease. The growing uses of machine learning in healthcare are examined in this study, which offers important insights for creating more intelligent and responsive machine learning solutions that enhance patient outcomes and accelerate medical research. Future directions include advanced machine learning models, multi-modal data integration, personalized healthcare, and real-world deployment challenges.***

Key Words: Machine Learning, Healthcare, Machine Learning Algorithms, Neural Networks, Medical Conditions.

I. INTRODUCTION

Machine learning is a branch of computer science which enable computers to learn from data without being explicitly implemented for a specific task [1]. By enhancing disease diagnosis, clinical judgment, and individualized therapy, machine learning is revolutionizing the healthcare industry [2]. Data-driven disease prediction, individualized therapy, and better results are made possible by this in the healthcare, particularly for long-term illnesses like diabetes [3]. In this sector, supervised and unsupervised learning are extensively used for disease prediction, early diagnosis, and treatment optimization [4]. Disease detection and diagnosis are greatly improved by deep learning methods like CNNs, RNNs, and DBNs, and EHR-based models improve risk assessment and decision-making [5]. These models improve accessibility, decision-making, and efficiency in healthcare, and chatbots driven by machine learning facilitate patient interaction, symptom assessment, and mental health support—particularly during COVID-19 [6] This paper summarizes the accuracy and efficacy of machine learning algorithms for healthcare disease diagnosis and prediction based on published research. This work also focuses to identify the most reliable algorithm for disease detection and prediction based on existing literature. The remainder of the paper is organized as follows. In the next part, the literature work is explained, which is followed by research approach. In section IV an overview of Machine Learning is presented. Section IV provides a tabular summary of the explored research efforts and a list of healthcare datasets along with accuracy. After that, we discuss our work before come to the conclusion.

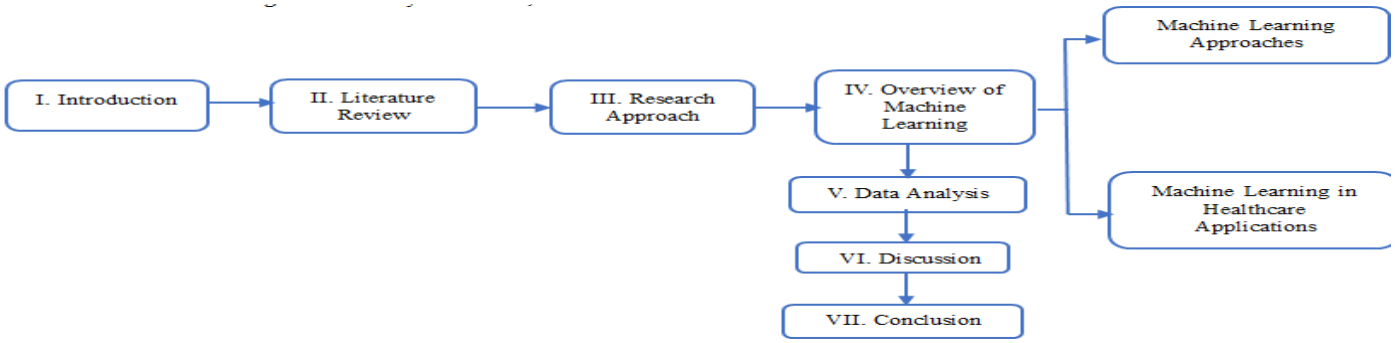


Fig 1. The structure of the review paper [5]

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II. LITERATURE REVIEW

Previous studies have examined several machine learning methods for disease diagnosis and prediction, with research frequently focusing on specific diseases or particular algorithmic techniques. Mostly studies focused on traditional techniques like Decision Trees and SVMs, missing newer advances like deep learning and ensemble techniques. K. Shailaja et al [7] provides a comprehensive review of machine learning applications in healthcare, mainly focuses on disease diagnosis and also highlights one of the best algorithms for particular disease. The analysis highlights how machine learning is transforming healthcare, particularly in disease prediction, identifying risk factors and detecting infectious disease outbreaks [8]. In this study the author used four machine learning algorithms such as support vector machines, K-nearest neighbor, logistic regression, and ensemble classifier for breast cancer diagnosis using the Wisconsin Diagnostic Breast Cancer (WDBC) and Breast Cancer Coimbra Dataset (BCCD)[9]. Another study has revealed the role of machine learning and deep learning in healthcare, particularly in disease prediction and detection and also highlight its applications in diagnosing conditions such as diabetic retinopathy, lung disease and brain tumors [10]. These methods improved diagnostic accuracy, aid in disease classification and emphasizes its role in analyzing structured and unstructured medical data, particularly in imaging techniques like MRI and CT scans, which are crucial for diagnosis [11] . Numerous illnesses, such as cancer, Alzheimer's, and respiratory conditions, have been successfully diagnosed using current deep learning techniques, especially CNNs, RNNs, and autoencoders [12]. Dayarathna et al. explores that deep learning has improved disease detection through synthetic medical imaging and further explores how advanced imaging modalities – including Magnetic resonance imaging (MRI), Computed Tomography (CT), and Positron Emission Tomography (PET) scans can lead to more precise disease detection [13]. It is transforming healthcare by improving disease diagnosis, personalized treatment, and clinical decision-making and models like CNNs and transformers are used to enhance medical imaging, predictive analytics, and drug discovery, help in early disease detection [14].

After conducting review of the literature various machine learning algorithms developed for medical purposes. Despite this, existing research has insufficiently characterized the potential of these algorithms to significantly improve the accuracy of healthcare data. So, this paper aims to study and assess the practicality of machine learning techniques in enhancing important healthcare data metrics, such as accuracy. The primary objective of this study is to bridge the knowledge gap in the application of machine learning in healthcare. The papers in this category examine healthcare models and assess their effectiveness, and offer insightful information for further study. This will guide researchers in developing more advanced machine learning-based solutions for healthcare applications.

III. RESEARCH APPROACH

This study demonstrates the applications of machine learning algorithms in the healthcare sector. The following steps were taken to achieve the research objectives.

A. Primary Selection

Initially, a collection of research papers was selected based on related search keywords. For this, a number of academic databases such as Google Scholar, PubMed, and IEEE Xplore were explored using relevant keywords such as “machine learning”, “machine learning in healthcare”, “machine learning techniques”, machine learning in healthcare applications”. The focus was on papers published between 2018-2025.

B. Inclusion and Exclusion Criteria

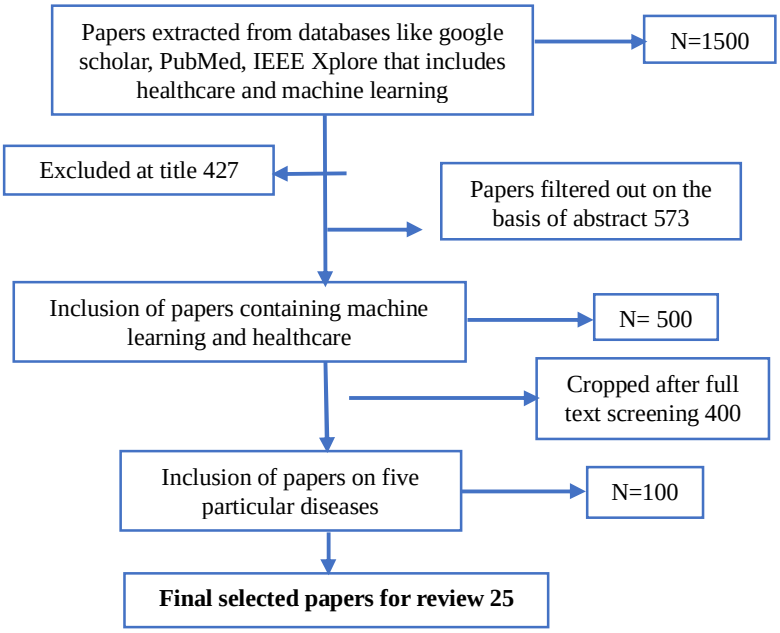
The research method follows a systematic approach to filtering and selecting relevant papers. A broad search is conducted to collect 1500 papers and most of the papers does not sum up the goal of this paper. It was necessary to establish inclusion and exclusion criteria.

- Criteria for Exclusion: This step involves screening title and of the papers to remove irrelevant and duplicate papers. Papers are excluded that do not explicitly focus on our objective. This step ensures that only studies that are relevant move forward.
- Criteria for Inclusion: We also identified some relevant literature that was not retrieved by the search phrase but necessary to be included in the study.

After screening, 500 papers remain that contain both Machine Learning and Healthcare applications. These papers are considered highly relevant and proceed to a full-text review stage. After finishing the exclusion and inclusion part, 400 papers are selected for final study. Then, 100 papers are selected that focused on five particular diseases.

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From the 100 disease-specific papers, 25 highly relevant studies are selected for comparative analysis. The final selection undergoes a comparative analysis, providing valuable insights into ML applications for healthcare, particularly for five key diseases.



IV. OVERVIEW OF MACHINE LEARNING

An overview of different types, methods, and techniques of machine learning, followed by a discussion on its applications in the healthcare sector.

A. Machine Learning Approaches

There is significant variance in the taxonomy of machine learning techniques across different works of literature. Table 1 presents various machine learning techniques applied in healthcare.

Table 1: Machine Learning

Type	Techniques	Description	Publication
Supervised Learning	Decision Trees (DT)	Divides the dataset into smaller units, helping classify patients and predict breast cancer survivability	[15], [16], [17]
	Random Forest (RF)	An ensemble classifier using multiple decision trees and majority voting, excelling in outlier detection and error reduction	[18]
	Support Vector Machine (SVM)	Separates data by finding an optimal decision boundary called a hyperplane	[19]
	Naive Bayes (NB)	Based on Bayes' theorem with feature independence, that efficiently predicts heart disease from clinical data	[20], [21]
	K-Nearest Neighbours (K-NN)	Classifier that assigns classes based on nearest neighbors, aiding in disease detection like heart disease diagnosis	[16]
	Artificial Neural Networks (ANN)	A network of interconnected input and output units, with each connection weighted, used by psychologists and neurobiologists to enhance and study computational models of neurons	[22]
Unsupervised Learning	K-Means	Partitions data into K groups using centroids, aiding patient stratification, personalized treatment, and healthcare data analysis	[23], [24]
	Hierarchical clustering	Creates a nested cluster hierarchy without requiring a preset group number, aiding patient segmentation for personalized treatment. It is of two types: Agglomerative and Divisive	[23], [25]
Deep Learning	Convolutional Neural Network (CNNS)	Designed for processing structured grid data, particularly images and widely applied in medical imaging for automatic feature extraction	[12]
	Recurrent Neural Network (RNNs)	Specifically designed for handling sequential data and used in early disease detection, patient monitoring, and anomaly detection	[26], [27]

B. Machine Learning in Healthcare Applications

1) Disease Diagnosis and Prognosis: Diagnosis is the identification of disease and Prognosis refers to predicting the future sequence of a disease based on current medical data and provides insights into how early detection and prediction using machine learning can lead to better treatment decisions and improved patient outcomes [28]. It also improves accuracy and enhance early disease diagnosis and detection. It discusses various techniques, including Naive Bayes, Random Forest, Support Vector Machines, and Neural Networks applied to diagnosing and identification of diseases such as heart disease, breast cancer, dementia, liver disease and neurological disorders [29][30]. Bayesian networks are used for enhancing disease diagnosis by identifying disease patterns and improve prognosis by predicting progression and treatment outcomes [31]. It enhances diagnostic precision by analyzing complex medical data, including imaging, genetics, and electronic health records and aids in early detection of diseases such as cancer, diabetes, and cardiovascular conditions, often outperforming traditional methods [32][4].

2) Personalized medicine: Personalized healthcare using machine learning enhances patient outcomes by delivering more customized and effective treatments. Healthcare professionals can determine the best treatments based on each patient's genetic profile and unique personal traits, including medical history, by evaluating patient data. This leads to improved patient outcomes and increased satisfaction rates [16], [33]. Machine learning is revolutionizing cardiovascular disease risk assessment within a personalized medicine framework[34]. Personalized medicine in this study tailors risk assessment and treatment for diabetes and CKD patients using ML models. It improves risk stratification, identifies key biomarkers for targeted care, and supports AI-driven clinical decisions[35].

3) Medical Imaging and Diagnostics: Medical imaging involves techniques for visualizing the body's interior for clinical analysis and these images helps in diagnosis, monitoring, and treatment of diseases[36]. The role of machine learning in medical imaging, focusing on radiology applications such as risk assessment, detection, diagnosis, prognosis, and therapy response[37] . These Models improve diagnostic accuracy by analyzing medical images, identifying anomalies, and predicting disease progression more effectively than traditional methods[38].

4) Patient Monitoring: It enhances patient monitoring and diagnostics by enabling early disease detection, predictive analytics, and real-time health tracking. In patient monitoring, wearable devices and remote health tracking systems are used to continuously assess vital signs, detect irregularities, and alert healthcare providers for timely interventions[38]. It enables continuous real-time health tracking using sensor data, audio signals, and imaging. Using physiological data like heart rate, breathing patterns, and movement from wearables and medical scans, Machine learning may identify abnormalities, forecast how illnesses may progress, and assist in guiding treatment decisions [39]. Additionally, smart health monitoring systems facilitate remote care, minimizing hospital visits and improving healthcare accessibility, especially for elderly and critically ill patients[40].

5) Predictive Analytics and Early Intervention: Machine learning enhances predictive analytics by identifying hidden patterns in vast healthcare datasets. ML models, including decision trees, neural networks, and SVMs, outperform traditional methods in forecasting disease progression, hospital readmissions, and emergency care needs. These predictive capabilities enable early interventions, personalized treatments, and efficient resource allocation, ultimately improving patient outcomes and reducing costs[41]. ML models, particularly random forests, demonstrate high accuracy in detecting early-stage diseases by analyzing clinical, imaging, and laboratory data. predictive analytics enables timely interventions, improving patient outcomes and reducing healthcare costs[42]. Healthcare professionals can detect diabetes, cardiovascular disease, and cancer at earlier, more manageable stages by utilizing this technology [43].

V. DATA ANALYSIS

These tables demonstrate the comparative effectiveness of different machine learning approaches for the use in healthcare applications.

Table 2: Breast Cancer

Year	Dataset Used	Used Technique	Accuracy (%)	Ref
2020	Wisconsin Breast Cancer	Artificial Neural Network	98.57	[44]
2021	Breast Cancer Wisconsin Diagnostic	Support Vector Machine	97.2	[45]
2023	National Cancer Institute (NIH) dataset	Decision Tree	98.7	[46]
		Ensemble Techniques		
2024	Demographic and clinical dataset	Neural Network	93.0	[47]
2025	Kaggle Breast Cancer Prediction Dataset	Logistic Regression	91.67	[48]

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Table 2 shows, the analysis of various studies on breast cancer prediction using machine learning has mainly improved predictive accuracy. Across different datasets, Artificial Neural Networks with 98.5%, Decision Trees and Ensemble Methods, SVM achieved the highest accuracy. On Clinical datasets, neural networks and logistic regression performed well. The findings suggest that deep learning and ensemble techniques are highly effective in breast cancer diagnosis.

Table 3: Heart Disease

Year	Dataset Used	Used Technique	Accuracy (%)	Ref
2020	UCI Repository	Random Forest	95.60	[49]
2022	UCI Repository	K-Nearest Neighbors	85.18	[50]
2023	Kaggle Cardiovascular Disease Dataset	Multilayer Perceptron	87.28	[51]
2024	Cleveland Dataset	K-Nearest Neighbors	99.65	[52]
2025	Cleveland Heart Disease Dataset	Artificial Neural Network	86%	[53]

Table 3 presents the comparative analysis of various studies that reveals datasets like Cleveland Heart Disease Dataset and the UCI Repository have been widely utilized for model training. Artificial Neural network performed well with 86% accuracy and with feature selection KNN demonstrated 99.65%. The findings emphasize the important role of preprocessing techniques, data quality and feature selection in enhancing model performance.

Table 4: Diabetes Disease

Year	Dataset Used	Used Technique	Accuracy (%)	Ref
2020	National Health and Nutrition Examination Survey	Random Forest + Logistic Regression	94.25	[54]
2022	PIMA Indian Diabetes Dataset	Twice-Growth Deep Neural Network	97.25	[55]
	LMCH Diabetes Dataset		97.33	
2023	Pima Indians Diabetes Database	Naive Bayes	76.07	[56]
2024	Diabetic2 dataset (Kaggle)	CatBoost	95.4	[57]
2025	PIMA Indian Diabetes Dataset (PIDD)	SVM + RBF Kernel	98.13	[58]

Table 4 presents multiple studies across different datasets and highest accuracy (98.13%) was achieved by using Support Vector Machine with RBF Kernel (SVM-RBF) on PIMA Indian Diabetes dataset. Deep learning techniques and ensemble methods such as 2GDNN, CatBoost have shown strong performance in diabetes prediction.

Table 5: COVID 19

Year	Dataset Used	Used Technique	Accuracy (%)	Ref
2020	600 patients, Hospital Israelite Albert Einstein	CNN + LSTM	92.3	[59]
2021	Epidemiology dataset from Mexico	Decision Tree	94.99	[60]
2023	Multiple datasets (14 studies reviewed)	Logistic Regression	92.9	[61]
2024	Kaggle Chest X-ray Datasets	VGG-19	98	[62]
2025	COUGHVID dataset	Enhanced Deep Neural Network with Coronavirus Herd Immunity Optimizer	98.5	[63]

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Table 5 explains, deep learning models are highly effective and outperformed traditional methods in COVID-19 detection. CNN based models (VGG-19) achieved 98% accuracy, while CNN-LSTM performed best with 92.3% accuracy on laboratory data. The Enhanced Deep Neural Network (EDNN) optimized with the Coronavirus Herd Immunity Optimizer (CHIO) achieving 98.5% accuracy.

Table 6: Glaucoma Disease

Year	Dataset Used	Used Technique	Accuracy (%)	Ref
2020	Fundus Image for Glaucoma Diagnosis Dataset	ResNet	99.6	[64]
2022	Countess of Chester Hospital	Multi-Layer Perceptron (MLP)	92%	[65]
2023	Electronic Health Records	XGBoost	81.61	[66]
2024	Stanford Clinical Warehouse	Random Forest	75.5%	[67]
2025	PAPILA dataset	Optimized DnCNN with SVM	98%	[68]

Table 6 shows, Deep learning techniques particularly ResNet achieved highest accuracy on Fundus Image for Glaucoma Diagnosis Dataset. XGBoost and Random Forest are also highly effective in structured electronic health record, achieved accuracies 81.61**%** and 75.5%, respectively. Optimized DnCNN with SVM and Multi-Layer Perceptron also demonstrated strong predictive capabilities.

VI. DISCUSSION

This analysis purposes to explore and classify the extremely accurate machine learning algorithms used in healthcare research based on accuracy. While machine learning in healthcare is being investigated by many academics due to its potential to enhance disease prediction, diagnosis, and treatment, it is still difficult to select the top algorithm for disease prediction. The selection of wrong algorithm can lead to wasted time and resources. Even though machine learning algorithms have been studied in healthcare before, the information is often fragmented across multiple papers, making it challenging for new researchers to gather and access comprehensive insights. As a result, researchers frequently face confusion and challenges when trying to identify the most suitable algorithm for their specific needs. To bridge this gap, the study examines and compiles data from the body of literature on machine learning's effectiveness in disease diagnosis. The purpose of this research is to provide relevant data in an individual comprehensive paper, eliminating the need for extensive literature searches. This study covers five different diseases and for each disease, and individual table is provided to display the best performing algorithms. This work helps researchers quickly choose the best illness prediction models by explaining machine learning's uses in healthcare, which reduces the difficulty and strain of literature reviews.

VII. CONCLUSION

Machine learning in healthcare has evolved significantly from early diagnostic models to advanced hybrid and deep learning techniques. Every disease has to be recognized in earlier stage in healthcare domain. The key findings of this paper emphasize the important role of preprocessing techniques, data quality and feature selection in enhancing model performance. The study explores various machine learning algorithms detailing their applications in disease diagnosis and prediction. In this study the review of various machine learning algorithms for the healthcare is conducted. This paper also includes various types of diseases and different diseases datasets are compared based on their corresponding accuracy. Future advancements will focus on data availability, model interpretability, personalized medicine, and ethical artificial intelligence integration to revolutionize healthcare decision-making. The paper suggests future directions for overcoming these challenges, such as developing more interpretable models, implementing secure data-sharing frameworks like federated learning.

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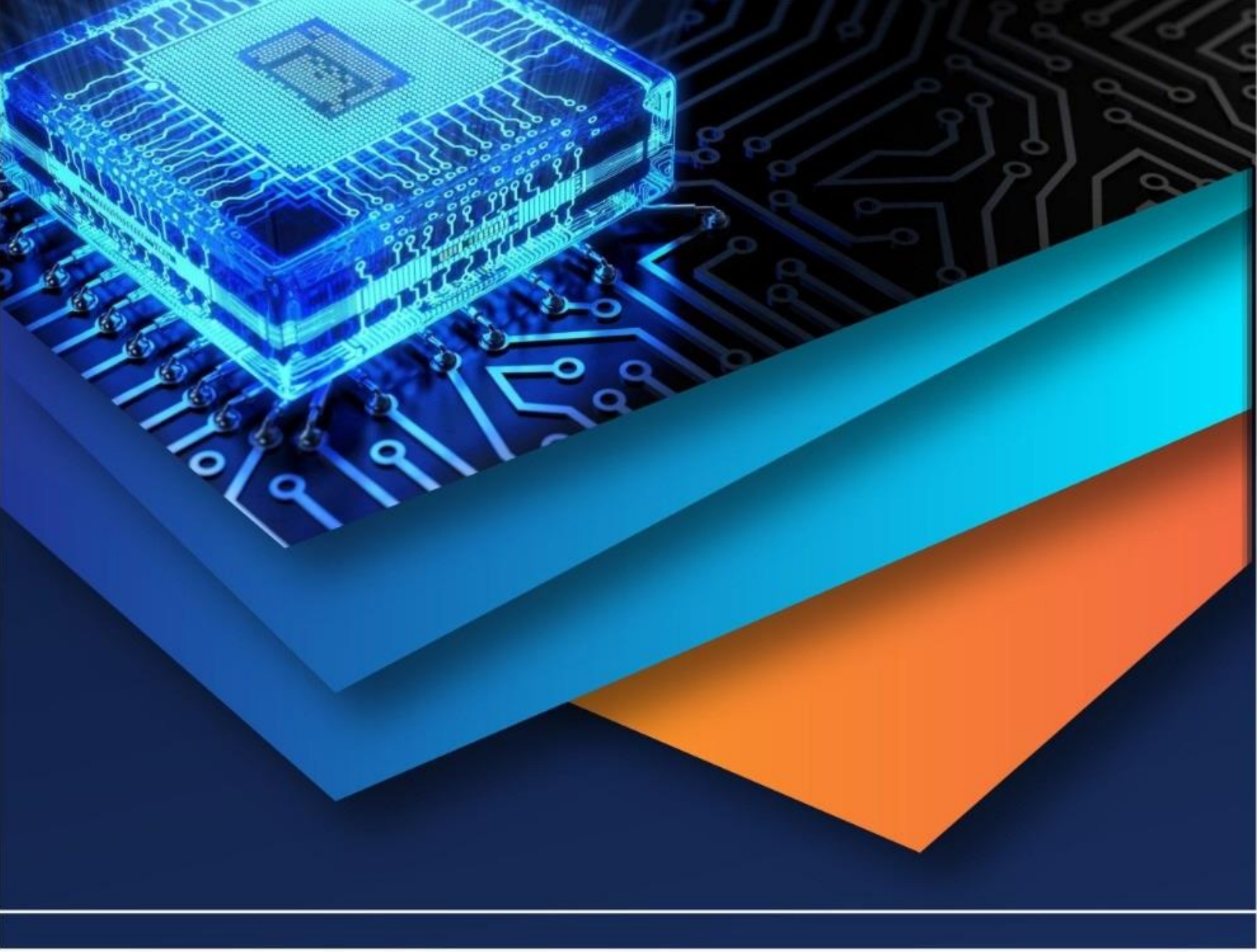
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