ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 13, 2022

A Systematic Review of Literature on Machine Learning for Healthcare

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Abstract Reviews the literature to identify the gaps and trends in Machine Learning and find a clear definition and context in which the term is used. A retrospective search of the literature was conducted using online databases like Web of Science and Google Scholar. Relevant bibliographic data on review articles were selected for analysis. From the analysis it is clear that most of the studies are from western countries and conducted on different diseases. Though some are from specific diseases, but very few studies are on use of Machine Learning for general health care

Key Words: Machine Learning, Healthcare, Review, Mapping, Bibliometrics

1.INTRODUCTION

The axiom " Health is Wealth "is true in all ages, but the health remains one of the critical determinants for the wellbeing of everyone in the society [1].Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) technology have brought on substantial strides in predicting and identifying health emergencies, disease populations, and disease state and immune response, amongst a few. Although, skepticism remains regarding the practical application and interpretation of results from ML-based approaches in healthcare settings, the inclusion of these approaches is increasing at a rapid pace[2].Machine learning (ML) and its applications in healthcare have gained a lot of attention. When enhanced computational power is combined with big data, there is an opportunity to use ML algorithms to improve health care. Examples of clinical applications of ML include the formulation of various clinical decision support systems. An important public health application of ML is the identification and prediction of populations at high risk for developing certain adverse health outcomes and the development of public health interventions targeted to these populations. [3]."Machine learning in healthcare applications are drug detection and analysis; disease diagnosis; smart health records; remote health monitoring; assistive technologies; medical imaging diagnosis; crowdsourced data collection and outbreak prediction; and clinical trial and research"(Siddique and Chow, 2021, p. 220)[4]. Various concepts related to ML need to be reviewed and integrated into the present-daymedical applications so that health professionals can effectively guide and interpret research in this area. An attempt has been made here to review the literature on ML for healthcare management.

2.REVIEW OF LITERATURE

Habehh and Gohelprovide a brief overview of machine learning-based approaches and learning algorithms including supervised, unsupervised, and reinforcement learning along with examples and discuss the application of ML in several healthcare fields, including radiology, genetics, electronic health records, and neuroimaging and also briefly discuss the

risks and challenges of ML application to healthcare such as system privacy and ethical concerns and provide suggestions for future applications[2]

Mishra et alexplains AI and it's various elements and how to utilize them in healthcare. It also offers practical suggestions for developing an AI strategy to assist the digital healthcare transition by helping practitioners understand complicated and varied types of data, Artificial Intelligence (AI) has influenced medical practice deeply. It is the use of a computer to mimic intelligent behaviour. Many medical professions, particularly those reliant on imaging or surgery, are progressively developing AI. While AI cognitive component outperforms human intellect, it lacks awareness, emotions, intuition, and adaptability. With minimum human participation, AI is quickly growing in healthcare, and numerous AI applications have been created to address current issues. [5]

Esteva etal discuss how computational techniques can impact a few key areas of medicine and explore how to build end-to-end systems. Present deep-learning techniques for healthcare and centering discussion on deep learning in computer vision, natural language processing, reinforcement learning, and generalized methods. Describe how computer vision focuses largely on medical imaging, and the application of natural language processing to domains such as electronic health record data. Similarly, reinforcement learning is discussed in the context of robotic-assisted surgery, and generalized deep learning methods for genomics are reviewed [6].

Miotto et alreviews the recent literature on applying deep learning technologies to advance the health care domain. Based on the analyzed work, suggest that deep learning approaches could be the vehicle for translating big biomedical data into improved human health. Gaining knowledge and actionable insights from complex, high-dimensional and heterogeneous biomedical data remains a key challenge in transforming health care. Various types of data have been emerging in modern biomedical research, including electronic health records, imaging, -omics, sensor data and text, which are complex, heterogeneous, poorly annotated and generally unstructured. Traditional data mining and statistical learning approaches typically need to first perform feature engineering to obtain effective and more robust features from those data, and then build prediction or clustering models on top of them. There are lots of challenges on both steps in a scenario of complicated data and lacking of sufficient domain knowledge. The latest advances in deep learning technologies provide new effective paradigms to obtain end-to-end learning models from complex data. [7].

Ghassemi et al highlights challenges and opportunities for members of the machine learning community to contribute to healthcare. Modern electronic health records (EHRs) provide data to answer clinically meaningful questions. The growing data in EHRs makes healthcare ripe for the use of machine learning. However, learning in a clinical setting presents unique challenges that complicate the use of common machine learning methodologies. For example, diseases in EHRs are poorly labeled, conditions can encompass multiple underlying endotypes, and healthy individuals are underrepresented. [8]

Bansal et al in their paper focused to study the various machine learning method for the predictive analysis. It includes various application area of machine learning, but mainly highlighting the role of machine learning in health care sectors. When we are dealing with the huge amount of data, we have to look forward to the techniques like machine learning, predictive analysis, pattern recognition etc. Specially in the health sector machine learning is growing too fast and also give productive challenges. For predicting future, machine learning algorithm plays an important role, through which system can learn and become productive by the passing time. Method and Techniques of Machine Learning are used in various fields. Among those Health care is of the field which takes lots of help from the techniques of predictions. Through the techniques of predictive analysis in health care, effective treatment and risk factor can be managed effectively among patients and improve the quality of health care. As per the modern scenario, there is a need of huge improvement in the healthcare in term of cost and other factors. Today healthcare sector faces problem in the electronic data management, disease prediction as per the symptoms, patient classification, computer-based diagnosis, risk factor etc. These challenges can be solved with the help of the machine learning tools and techniques. [9]

Rathore and Mannepalli reviewed the Machine Learning Techniques and Applications for Health Care and deep learning techniques for the health care sectors, with some key features, In this review they mentioned the machine learning techniques will be provided for the variety of applications, then review about the previous author work in health care sectors and highlight some important diseases with their feature extraction techniques and accuracy [10].

Ahamed et al conducted research to examine medical IoT improvements in terms of enabling technology, health care services, and implementations to address a variety of health care challenges. Additionally, potential issues and concerns about the Health Care IoT system are explored. Asa consequence, future researchers interested in investigating and discovering new applications for health care IoT will have a credible resource for learning about the technology's many applications.Over the last decade, health care enabled services and accompanying advanced technology have been the subject of much research. Medical equipment, sensors, and healthcare professionals may all be linked through the Internet of Things (IoT) to deliver high-quality medical services everywhere. Patient safety has improved as a consequence, health care costs have decreased, access to health care has grown, and the sector as a whole has become more efficient and productive. According to recent study, Internet of Things (IoT)-based technologies offer enormous promise for enhancing health care. The most effective data analysis methods now use machine learning-assisted techniques. Due to the conductivity of the top three layers, intelligent applications and services such as sickness detection, behavioural recognition, and intelligent support may be supplied. [11].

Yadav et al. studied A behavioral analytics approach uses big data analytics in combination with machine learning (ML) to identify patterns, trends, aberrations, and other useful insights. The behavior of an individual can be analyzed by expressions, postures, and activity levels.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 13, 2022

Using ML algorithms could revolutionize the way clinicians make decisions in health care sector. Studies of human behavior have been conducted in a range of scientific disciplines (e.g sociology, psychology, computer science). ML algorithms have the potential to transform the way doctors and instructors make choices. This methodology has been slow to be adopted by behavior analysis experts to maximize its application to practical issues and to aid them in learning more about human behavior. ML algorithms are dominating the healthcare industry. Recent researches have indicated that these techniques can be used to anticipate disease based on health data. Our study examines several machine learning algorithms used in early disease detection and identifies key trends in their performance. The analysis suggests that human behavior may play a role in a variety of conditions, including diabetes, cancer, heart disease, autism, mental illness, Alzheimer's, and others. A number of daily habits are associated with this behavior, including food, respiration rate, blood pressure, voice output, social abnormalities, insomnia, and so on. A few examples of ML applications integrated into healthcare services are naive bayes (NB), support vector machines (SVM), random forest (RF), and convolutional neural networks (CNN). In a variety of cancer classification applications, these models are proved to be highly efficient in diagnosing various cancer types. This review includes a number of research investigations that employ ML to analyze behavioral data. As we gain further insights into the factors influencing organisms' behavior, we are able to create computational models which allow disease prediction and management to become more accurate [12].

Eva et al in their study of diabetes patients Day by day machine learning is getting its prominence. Recommending something using machine learning is a popular area for enthusiastic researchers. The recommendation system is getting more precise as days go by. In the medical industry, a recommendation system used vastly to recommend a good diet. A recommendation system would be a useful tool if we can make it for diabetes patients. As diabetes, patients need to follow diet plans and work out strictly. Diabetes patients need to control blood sugar in his or her bloodstream to stay healthy. Using machine learning for recommend food and workout plan is an effort to make a precise recommendation system for Bangladeshi diabetes patients. Various classification algorithm is use in this system to detect diabetes risk of the user as per his or her input. Such as, Decision tree, Naive Bayes and Support vector machine. After classify the diabetes risk the system will suggest some best diet plan and workout routine by query selection method [13].Nakhashi et al presented a random forest-based ensemble machine learning technique to work on patient data, also called vital sign input, from ICU[11]. Sasubilli and Kumar in their article discuss the implementation of different health care architecture is focussed, which uses live data gathered from different sources over the globe. Machine learning approaches and the big data framework are combined to design a prediction model and data handling techniques[14].Nagarajaiah et alprovides a comprehensive examination of the current state of the art regarding the use of a wide variety of machine learning algorithms to the process of diagnosing mental health problems. In addition to this, this study will discuss about the obstacles, restrictions, and opportunities that lie ahead in the field of machine learning when

it comes to mental health. This study constructs a library of research articles and studies on machine learning approaches employed for the prediction of mental health concerns by searching credible sources.

Researchers have been driven to investigate the possible role that machine learning may play in the treatment of mental health illnesses as a result of the increasing prevalence of mental health issues and the need for more effective medical care. This article Moreover, this systematic review is conducted by using the PRISMA methodology. After the process of elimination and selection, a total of 30 unique research articles are reviewed. Schizophrenia, bipolar illness, anxiety, depression, PTSD, and other mental health issues are only some of the categories into which we've placed the collected research articles. This section will first analyse the findings and then reflect on the obstacles and restrictions that have been encountered by the community doing research on the application of machine learning to mental health. In addition, this study outlines the potential directions that future study and development efforts in the field of applying machine learning toward mental health may take in order to take advantage of the opportunities presented [15].

Thamaraimanalan et alimplemented with spectral clustering and radial basis function network algorithm and performed well by executing with higher accuracy of value in prediction of mental health data about the patient using machine learning approaches and techniques.The proposed work helps to detect the values of significant ECG parameters with informative values as effective and high accuracy data predicting using the parameters as time, frequency and energy from signal of ECG[16]

Alsinglawi et alintroduces a predictive research architecture to predict Length of Stay (LOS) for heart failure diagnoses from electronic medical records using the state-of-art- machine learning models, in particular, the ensembles regressors and deep learning regression models. Results showed that the gradient boosting regressor (GBR) outweighed the other proposed models in the study. The GBR reported higher R-squared value followed by the proposed method in this study called Staking Regressor. Additionally, The Random forest Regressor (RFR) was the fastest model to train. Outcomes suggested that deep learning-based regressor did not achieve better results than the traditional regression model in this study.The work contributes to the field of predictive modelling for electronic medical records for hospital management systems. Predicting Cardiovascular Length of stay based hospitalization at the time of patients' admitting to the coronary care unit (CCU) or (cardiac intensive care units CICU) is deemed as a challenging task to hospital management systems globally. Recently, few studies examined the length of stay (LOS) predictive analytics for cardiovascular inpatients in ICU. However, there are almost scarcely real attempts utilized machine learning models to predict the likelihood of heart failure patients length of stay in ICU hospitalization [17].
Abad et al proposed and implemented different machine learning architectures to determine the efficacy of the Acute Physiology and Chronic Health Evaluation (APACHE) IV score as

well as the patient characteristics that comprise it to predict the discharge destination for critically ill patients within 24 hours of ICU admission.within the eICU Collaborative Research Database (eICU-CRD) populated with de-identified clinical data from adult patients admitted to an ICU between 2014 and 2015. Machine learning models were developed to predict four discharge categories: death, home, nursing facility, and rehabilitation. These models were trained and tested on 115,248 unique ICU admissions. To mitigate class imbalance, we used synthetic minority over-sampling techniques. Hierarchical and ensemble classifiers were used to further study the impact of imbalanced testing set on the performance of our predictive models. Amongst all of the tested models, XGBoost provided the best discrimination performance with an area under the receiver operating characteristic curve of 90% (recall: 71%, F1: 70%). Our findings indicate that the variables used in the APACHE IV model for estimating patient severity of illness are better predictors of hospital discharge destination than the APACHE IV score alone. Incorporating these models into clinical decision support systems may assist patients, caregivers, and the ICU team to begin disposition planning as early as possible during the hospitalization[18]. Predicting and detection of heart disease has always been a critical and challenging task for healthcare practitioners. Hospitals and other clinics are offering expensive therapies and operations to treat heart diseases. So, predicting heart disease at the early stages will be useful to the people around the world so that they will take necessary actions before getting severe. Heart disease is a significant problem in recent times; the main reason for this disease is the intake of alcohol, tobacco, and lack of physical exercise. Over the years, machine learning shows effective results in making decisions and predictions from the broad set of data produced by the health care industry. Some of the supervised machine learning techniques used in this prediction of heart disease are artificial neural network (ANN), decision tree (DT), random forest (RF), support vector machine (SVM), naïve Bayes) (NB) and k-nearest neighbour algorithm. Furthermore, the performances of these algorithms are summarized [19].

Sabarmathi and Chinnaiyan proposed a unique approach towards decision making process and better quality care in healthcare applications is developed by using the Machine Learning (ML) concepts as an alternative mode for identifying the characteristics and patient satisfaction (PS) in the proposed healthcare system. Extracting the information from raw data using some algorithmic approach is known as Data mining. In this a ML approach is used in determining the patient satisfaction in health care sector. Applied regression models to determine the patient satisfaction and also correlation methods is identified as an important attribute to be considered in determining the better quality of health care application models. The data set is taken based on the opinion on three types of data such as a) patient opinion towards hospital care b) nurse opinion towards workplace and c) Administrative aspects of healthcare. Findings revealed high accuracy in Regression (88%), that helps in concluding by considering the administrative and workplace attributes related to patient satisfaction. The results are validated using traditional statistical methods like binomial correlation and linear regression [20].

Xiang et al reviewed machine learning algorithms for health-care management medical big data systems. Intelligent diagnosis originated from the introduction of mathematical models as a computer-assisted diagnostic tool in clinical science. Later, various expert systems have gradually appeared. There are many methods for classification in machine learning, including the support vector machine, decision tree algorithm, logical regression, integration method and so on. Among them, support vector machine is the most widely used, it has strong robustness and can then the model nonlinear decision boundary, and there are many optional kernel functions. We review from the 2 major aspects. (1) The input dataset consists of examples, each of which is an input data without an explicit output value. The most studied and widely used method in unsupervised learning tasks is clustering. (2) Semi-supervised learning is to add unlabeled data to the supervised classification algorithm to achieve semi-supervised classification. It is between supervised and unsupervised learning. It belongs to a learning method combining the two. The proposed review will have the efficient support for the further analysis [21].

Machine Learning (ML) refers to a variety of statistical approaches that enable computers to learn from experience without being explicitly programmed. This learning generally manifests itself as modifications to how an algorithm operates. For physicians, predicting and identifying heart illness has always been a challenging and time-consuming task. Hospital and other institutions provide pricey operations and treatments to treat hearing issues. Early heart disease identification will help people all around the globe since it will enable them to get the proper care before it worsens. Overconsumption of alcohol, cigarette smoking, and inactivity have been the main contributors to heart disease in recent years. The healthcare industry has used machine learning to generate predictions and decisions from a significant quantity of data across time. The supervised machine learning techniques used in this prediction of coronary heart disease include artificial neural network (ANN), decision trees (DT), Random Forest (RF), support vector systems (SVM), nave Boltzmann (NB), and nearest neighbour algorithm. Additionally, a summary of the outcomes from several algorithms is provided [22].

Kumar et al has developed a system using Naive Bayes Classifier which evaluates the symptoms that person give as an input and gives the disease as an output. The system focuses on accuracy, the more numbers of a symptoms furnished by the person as a input the disorder prediction as a output will be better. Work can enhance the health care industry to zenith and give cure to world.The wide variety of computer-based technologies within the healthcare industry has led to the gathering of electronic data. Due to the massive number of information, medical professionals are faced with the challenge of accurately diagnosing signs and figuring out diseases at an early stage. In medicine, misdiagnosis could be a major factor leading because of poor treatment and diagnosing the disease when it's serious. However, supervised machine learning techniques have demonstrated the potential to surpass conventional diagnostic procedures and assist medical professionals in diagnosing high-risk

diseases. Mostly people feel lazy to visit a hospital, and concern a doctor for a minor complication. However, this small problem can pose significant medical[23].

With the increasing popularity of cancer informatics and the advent of "data revolution," it is becoming imperative to discuss the ethical implications of machine learning (ML) and artificial intelligence (AI) on the society and cancer care. Machine learning can be defined as the application of computers and mathematical algorithms to learn from data and predict future outcome. Artificial Intelligence, on the other hand, is built on deep learning as a machine learning technology, and has proved very powerful at solving problems in recent years. There is now hope that machine learning and AI will be able to diagnose cancer, make recommendations for treatment plans, and do countless other things to transform cancer health. However, there are evolving ethical issues that arise in the context of applying ML and AI for optimizing cancer care. This article examines the ethical issues of applying ML and AI in cancer care and classifies them into three major categories: bias, the societal implementation of the technology, and the effects of big data analytics on cancer patients. Our hope is to stimulate discussion about these important ethical implications, which will increasingly need to be addressed in the oncology community [24]

3. MAPPING AND VISUALISATION OF CONCEPTS

Literature search was conducted on Web of Science using key words “Machine Learning” and “Healthcare” and “ReviewThe data was analysed using Bibliometrix software on RStudio platform.”. Table-1 shows the details of data collected. Nine hundred seventy (970) documents were retrieved related to machine learning contributed by four thousand six hundred forty (4640) authors from 497 sources. Time span for the literature is 2009 – 2022.

Annual scientific production of authors in machine learning is at peak in the year 2022 (Fig-1). Author collaboration is concerned majority of them collaborate with authors from United States of America (Fig-2). Authors from all countries collaborate while working on Machine learning (Fig-3). In recent years, there is trend to study ”Classification”, ,”Prediction”, “Diagnosis: and “Big data” in Machine learning (Table-3),

Table -1: Main Information about Data

Description	**Results**
Timespan	2009:2022
Sources (Journals, Books, etc)	497
Documents	970
Document Average Age	1.54
Average citations per doc	24.44
DOCUMENT CONTENTS	
Keywords Plus (ID)	2739
Author's Keywords (DE)	2663

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 13, 2022

AUTHORS	
Authors	4640
Authors of single-authored docs	32
AUTHORS COLLABORATION	
Single-authored docs	32
Co-Authors per Doc	5.32
International co-authorships %	40.62
DOCUMENT TYPES	
Review	922
Review; early access	48

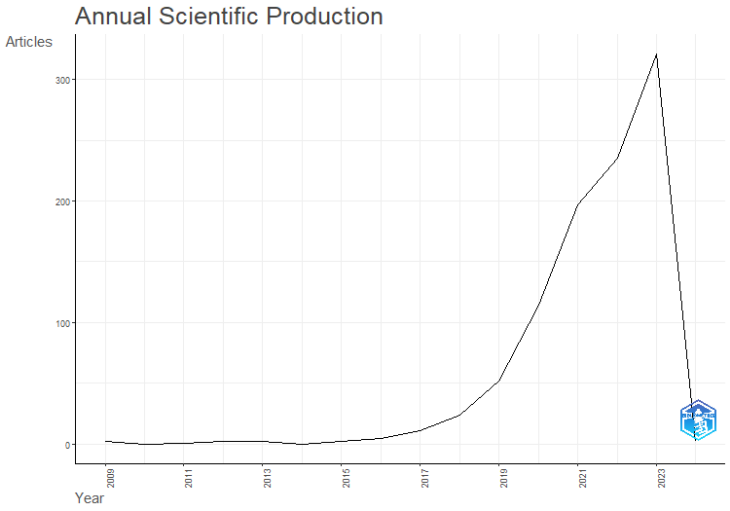

Fig -1: Annual Scientific Production

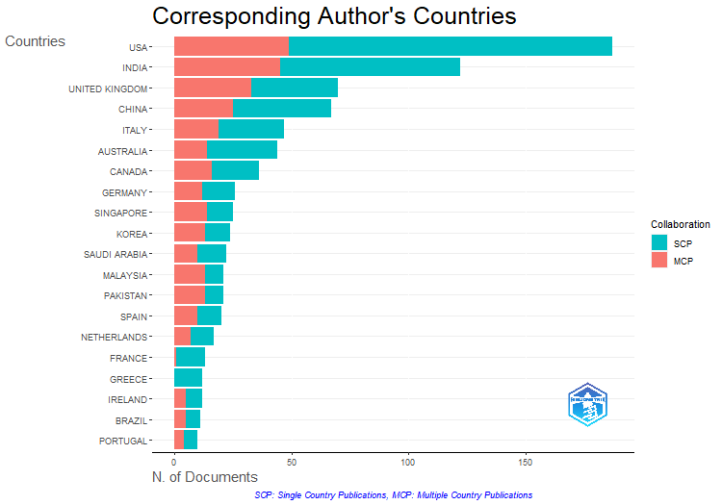

Fig -2: Corresponding Author Country wise

Table -2: Author Collaboration World Data

From	To	Frequency
USA	UNITED KINGDOM	48
USA	INDIA	30
USA	CANADA	23
INDIA	UNITED KINGDOM	20
UNITED KINGDOM	ITALY	20
USA	ITALY	19
USA	CHINA	18
USA	GERMANY	17
CHINA	AUSTRALIA	15
INDIA	CHINA	15
UNITED KINGDOM	CANADA	15
USA	AUSTRALIA	14
CHINA	SINGAPORE	13
INDIA	SAUDI ARABIA	13
CHINA	UNITED KINGDOM	12
USA	GREECE	12
USA	NETHERLANDS	12
USA	SPAIN	12
USA	SWITZERLAND	12

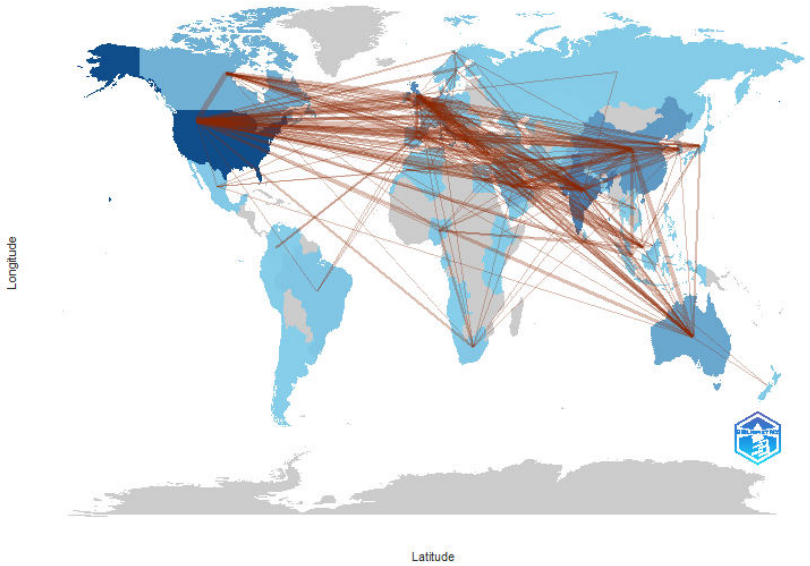

Fig -3: Author Collaboration World Map

Fig -4: Word Cloud

3. CONCLUSIONS

Machine learning has emerged as an important technique in health care for predicting and diagnosis of diseases at early stage. For physicians, predicting and identifying illness has always been a challenging and time-consuming task. Early identification will help people all around the globe since it will enable them to get the proper care before it worsens. Further techniques need to be developed and use Machine Learning for healthcare management.

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