Issues and Challenges associated with Machine Learning Tools for Health Care System: A Review

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ABSTRACT- The support of Artificial intelligence (AI) can be used to update traditional healthcare services, and it can efficiently serve society. Using machine learning tools, the diagnosis process can be automated, and practitioners can process large-scale clinical data to generate quick medical advisory for patients. This paper will analyze the contribution of machine learning tools in the medical domain. It will discuss prediction schemes for the healthcare industry, drug discovery, and human trials using machine learning and surgical operations with machine learning assistance, etc.

Keywords- Machine Learning, Health Care, Automated Diagnosis.

I. INTRODUCTION

Traditional healthcare services detect diseases basis on the patient's symptoms and recommend different treatments. All these processes produce a large scale of clinical data. Manual processing of this data is very complex and time-consuming, thus may delay the diagnosis process, and patients' health cannot be recovered timely. Artificial intelligence (AI) plays an essential role in processing this clinical data, and efficient results can be achieved in a timely manner. Following figure 1 shows the classification of clinical data:

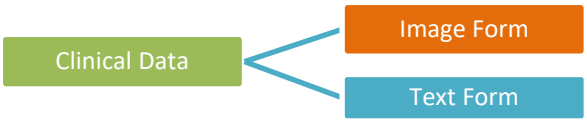

Figure 1. Classification of Clinical Data

The Image form of clinical data consists of the following:
(a) Medical Images: These images can be produced using different technologies as given below [37-42]:

Figure 2 CT scan of Lungs

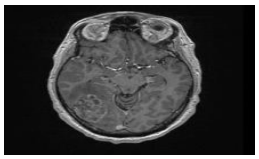

Figure 3 MRI scan of the Brain

Figure 2 shows the CT scan of the Lungs that is produced using multiple x-ray images with different angles/cross-sections. Figure 3 shows the Magnetic Resonance Imaging (MRI) scan of the Brain that is produced using radio waves and magnetic fields.

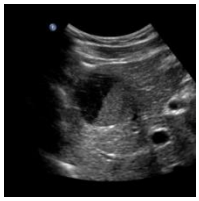

Figure 4 Ultrasound image of Lever

Figure 5 X-ray of Chest

Figure 4 shows the ultrasound image of Lever that is produced using high-frequency sound waves. Figure 5 shows the X-ray image of the chest that is produced using ionization radiation.

Figure 6 Nuclear medicine of Heart

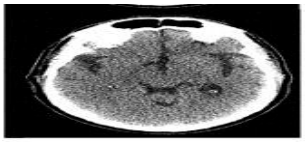

Figure 7 Positron-Emission Tomography of Brain

Figure 6 shows the Nuclear medicine image of the Heart that is produced using radioactive tracers. Figure 7 shows the Positron- Emission Tomography image of the Brain that is produced using radionuclides. As per requirements, the practitioner refers the scan type to each patient.
The Text form of clinical data consists of the following:

- Meta Data: Lab test report, patient personal information, current health status, medical history, feedback, disease, diagnosis and treatment details, etc.

Above discussed data is used to build a complete medical record of patients, and AI can extract customized facts with the help of various machine learning algorithms. These facts may be used for:

- Prediction of disease and diagnosis through
  - Medical image processing
  - Clinical Text data mining
- Development of an automated decision support system
- Drug discovery and human trials
- Surgical operations using robotics

Following figure 8 shows the various approaches that can be adapted for machine learning to achieve the above-discussed points:

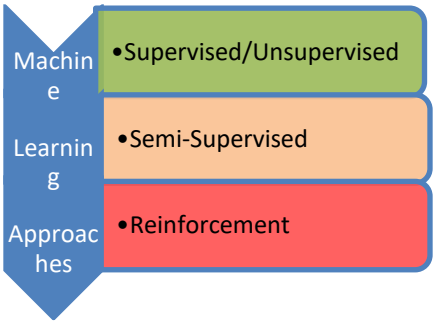

Figure 8. Machine learning Approaches

In the case of supervised learning, input datasets are used for training, whereas in unsupervised learning, labeled datasets are used for semi-supervised learning. Reinforcement learning uses feedback values to refine the output [1-5]. The sections below explore the contribution of various researchers for the different stakeholders (practitioners/patients).

II. MACHINE LEARNING-BASED PREDICTION SCHEMES FOR THE HEALTHCARE INDUSTRY

Using clinical data, training datasets can be developed, and estimation of current disease stage and health status can be determined using machine learning algorithms that can enhance the proficiency in disease detection and diagnosis process. The following section describes the machine learning-based prediction for healthcare services:

M. D. Samad et al. [6] explored machine learning-based methods that can predict survival accuracy using limited input variables for echocardiography outcomes. The study found that traditional methods use Ejection Fraction and Comorbidities based prediction models, which are less accurate than the machine learning algorithms.

Y. Xue et al. [7] developed a prediction model for patient readmission and compared its performance to the Support Vector Machine/Random Tree based methods. Analytical results indicate that Functional Independence Measure method outperforms traditional methods. Training and validation were performed using existing clinical data, and accuracy and sensitivity were adjusted by finding the optimal cutoff point of the receiver operating characteristic curve. Results state that it can reduce the overall treatment cost as well as it can also improve the quality of healthcare services. A. Clim et al. [8] investigated the relationship between chest sounds and the level of hypertension. They found that a prediction scheme based on Kullback-Leibler Divergence is more accurate and can enhance clinical decision support compared to traditional methods. C. R. Olsen et al. [9] investigated machine learning algorithms' role in diagnosing heart diseases. The study indicates that these methods can assist the practitioners for diagnosis and can also be used to develop the prediction models per the patient's classification. Integrating these algorithms with the BigData framework can also analyze large-scale disease datasets.

F. Y. Qin et al. [10] developed a predation framework for the health analysis of elderly patients. It builds the predicates by perfuming the feature classification. Finally, a dataset is used for training and validation purposes. Experimental results show that it outperforms in terms of prediction accuracy as compared to traditional schemes (Artificial Neural Network/Super Vector Machine). X. Du et al. [11] developed a perdition model for detecting cancer symptoms in early-stage patients. It uses both linear/non-linear models to process the input parameters, and analysis shows that the proposed scheme outperforms in terms of various parameters, i.e., sensitivity/ Specificity /F1-Score/ Precision/ Recall/ROC Curoff, etc., as compared to traditional methods. Y. Wang [12] et al. developed a scheme to predict the probability of mental disorders after brain surgery. After calculating the risk factors associated with the patients, practitioners can adapt the appropriate therapy/drugs/treatment to reduce the risk of such disorders. The proposed scheme was analyzed using different algorithms (Decision Tree/Regression/Random Forest/Gradient Boosting) under the constraints of various parameters (sensitivity/ Specificity /F1-Score/ Precision/ Recall/ROC Curoff etc.). Experimental results indicate that higher risk factors of mental disorders can be reduced with the help of machine learning algorithms.

K. N. Qureshi et al. [13] utilized a mobile platform to collect the patient data that can be used to forecast heart disease. Compared to existing methods (Neural Network/ Support Vector Machine/Native Bayes), it outperforms in terms of optimal accuracy/sensitivity/specificity. It can

be further extended to analyze the impact of various Brain-related injuries on human beings. A. Akbulut et al. [14] developed a prediction scheme that utilizes the clinical datasets to predict anomaly status using different binary classification models. Experimental results show that the decision tree-based model is more accurate than another state-of-the-art model. It can be further migrated to the mobile platform to analyze large-scale datasets. K. N. Kunze et al. [15] developed a random forest approach to predict patient dissatisfaction after knee surgery. It considers various facts, i.e., age, allergy to medicines, etc., as input for the prediction chart. Experimental results indicate that risks related to health and dissatisfaction level can be accurately predicted, and patients' health status can be optimized using feedback. However, the lack of data validation is still an open issue. It can be resolved in the future. A. Talukder et al. [16] used different machine learning algorithms (logistic regression/linear discriminant analysis/support vector machines/k-nearest neighbors /random forest) to predict the malnutrition level in children. Countrywide data was collected and used for perdition purposes. Analysis shows that random forest outperforms higher specificity/accuracy/ sensitivity compared to other methods. This study can be further used to manage malnutrition, identify the associated health risk, improve healthcare services, etc.

III. Automated Decision support system

In the case of the primary healthcare system, practitioners manually examine the clinical data that may be error-prone, and its processing is quite complex and time-consuming. All these factors degrade the efficiency of decision-making and affect the diagnosis process. The traditional process of medical data examination for decision-making can be altered using machine learning algorithms. The section below discusses the contribution of the researchers in this area.

H. Yin et al. [17] developed a framework that collects data from wearable sensors and computed-assisted medical systems. A machine learning-based scheme is used to process and classify the patients as per disease categories. Output data is further used for decision-making and diagnosis purpose. Experimental results show that it can improve treatment accuracy, and practitioners can utilize multiple datasets to improve healthcare services. S. Anakal et al. [18] introduced a decision support system to diagnose chronicle lung diseases. It uses different machine learning schemes, i.e., Decision trees/Support vector machines/neural networks/ Classifier Ensembles, etc. Experimental results show that practitioners can redefine their treatment strategies and utilize the system feedback to manage patient drug levels. It can be integrated with a cloud platform to provide telemedicine support for remote areas.

A. P. Eremeev et al. [19] analyzed for decision-making to process the medical data at a large scale that may be available in images or text form. It is also quite complex to store and co-relate the facts in this data. Study shows that NoSql databases are more suitable to store this type of dataset and supports optimal response time for query execution, and can be easily integrated with machine learning tools as compared to traditional databases. K. Shailaja et al. [20] studied various machine learning methods that can be used for the diagnosis and decision support of various diseases (heart/diabetes /cancer). Analysis shows that different schemes have different accuracy level for each type of disease, i.e., native bays has the highest accuracy level for diseases related to the Heart. In contrast, classification and regression-based methods provide more accurate results for diabetic patients and cancer patients; support vector machine provides the highest prediction accuracy. The analytical data of this study can be utilized further to improve the accuracy level of other machine-learning tools.

H. R. Mansilla et al. [21] presented a decision support framework that can analyze the risk of infection after surgery. Practitioners can use the alternative treatment type to avoid these side effects. It uses the combination of a support vector machine and a decision tree to balance the accuracy level in results. Experimental outcomes show that estimating infection risk can optimize the diagnosis strategies. A. Yahyaoui et al. [22] developed a decision-support framework for diabetic patients that use a deep learning approach for disease prediction and diagnosis support. Experimental results show its performance in terms of prediction accuracy compared to traditional approaches (Random Forest/Support vector machine). Its accuracy can be further enhanced by integrating deep feature extraction. C. Comito et al. [23] developed an automated decision support system that can assist the practitioners as per the available datasets built using different medical data resources (Lab test/patient health records). Experimental results show that deep learning can detect symptoms early, and diagnosis plans can be suggested for identified diseases. A. Triantafyllidis et al. [24] explored the integration of machine learning schemes with electronic health records and decision support systems to predict and manage childhood obesity. Analysis shows that prediction accuracy can be achieved using decision trees/neural networks, and effective treatment plans can be designed to prevent obesity at early stages. The analytical data of this study can be used for mobile diagnosis platforms. W. O. N.d. Hollosy et al. [25] used supervised learning methods (Decision Tree/Boosted Tree/Random Forest) to develop a decision support framework to diagnose patients with low back pain. Analysis shows that few parameters vary during testing and data validation (accuracy/ sensitivity/ precision/ specificity). However, the overall time of the diagnosis process can be reduced using this framework, and it can be integrated with large-scale global datasets. N. P. Smadja et al. [26] investigated the support of machine learning methods for the decision support system. The study found that the performance of these schemes depends on the input datasets having limited facts about symptoms. For each disease type, the accuracy of decision-making may differ.

IV. Drug discovery and human trials using machine learning

Drug development is quite a complex and time-consuming process and directly relates to the type of disease, symptom, dose, intake frequency, etc. All these factors play an essential role in human drug trials, as new drugs may have some side effects on the human body. There is a need to recognize the risk factors associated with its development process and reactions to patient's health/ disease etc. Machine learning offers an automated platform for drug development and trial. The section given below explores the solutions developed by other researchers in the relevant domain:

L. Zhao et al. [27] investigated the challenges associated with pharmaceutical research and drug development. The study found few facts (data source/ quality/ format/ validity/authenticity/data rate/ volume/ values) directly influencing drug development cost. Large-scale data related to the drug can be analyzed through the integration of machine learning/deep learning algorithms over big data platforms, thus reducing the overall R&D cost of drugs. C. Réda et al. [28] surveyed the association of diseases with different drugs and their impact on the drug development process. Analysis shows that a complete knowledgebase of diseases can be acquired using machine learning algorithms and it may reduce the research cost as well as its human trials may be conducted at earlier stages and feedback from number of successful trials can be utilized to refine the drug modeling process/dose/accuracy level etc. R.

Ietswaart et al. [29] developed a random forest approach based model to find out the association of drug reactions over patients. Several drugs was used for training purpose. Its performance was verified using different parameters (accuracy/correlation coefficient/recall curve/ precision etc.). Outcomes show that large-scale analysis of drug reaction associations can optimize the failure rate of drug trials. Machine learning also provides a platform for random experiments, and no human/animal is required. N. T. Issa et al. [30] explored the drug development issues related to cancer/tumor. They found that drug repurposing strategies can be defined using existing large-scale cell datasets to diagnose this disease, and drug development costs can be optimized. Analysis shows that training datasets can be updated using feedback to maintain experiments' accuracy. M. Ali et al. [31] investigated several machine learning approaches to extract the cell-related data from cancer patients and prepare training datasets for detection and diagnosis purposes. Analysis states that feature extraction of cells and drug response to patient's health can be used to predict the response of cancer drugs as well as these outcomes can also optimize the drug development cost.

V. Surgical operations with machine learning assistance

Surgery is a complicated operation through which patients may be recovered or not. Even after surgical operation, it may have the side effect over the patient health. So there is a need to investigate the risk and side effects of surgery on a patient's health. Machine learning algorithms can be utilized to overcome from these issues as described below:

L. Štěpánek et al. [32] investigated the role of machine learning in plastic surgery and multiple facial expression dataset was used to perform Multivariate linear regression using R language. Experimental results indicate that a neural network can achieve higher accuracy for facial geometry, and Bayesian naive classifiers/decision trees can be used to map the facial image to emotions. T. J. Loftus et al. [33] explored the risk associated with the surgical wards where the quick assessment of high-risk patients is essential, and error-prone diagnosis and treatment recommendations may lead to the failure of healthcare services. Using wearable sensors, real-time health analysis and electronic health records can be generated for such risks. The medical data can be further processed using machine learning techniques to recognize the symptoms at earlier stages and achieve higher accuracy. A. W. Schwartz et al. [34] studied virtual reality-based surgical operations and investigated their integration with machine learning schemes. The analysis found that combining both technologies can be utilized to develop a large-scale knowledge base to help the stakeholders. L. Štěpánek et al. [35] analyzed facial feature extraction and their classification using a machine learning algorithm that can refine facial plastic surgery outcomes. Analytical data shows that geometry features, along with sufficient datasets as evidence both, can be enforced to maintain the quality of facial attractiveness. K. Merath et al. [36] analyzed the compilations associated with the different types of surgical operations (Liver/ pancreatic/ colorectal) and developed a solution to predict the complications using decision tree models. Experimental results show its performance in terms of higher prediction accuracy and efficient risk analysis related to diagnosis. Its scope can be enhanced using electronic health record system.

VI. Summary Table

	Contribution
Section-I	This section introduced the concept and role of artificial intelligence

	based solutions for healthcare industry. It described the various sources of clinical data, its forms and the available machine learning based approaches etc.
Section-II	This section described about the various existing solutions that can be used for prediction of disease and its diagnosis purpose, patient's health status etc.
Section-III	This section discussed the automated decision support system and clinical data collection/processing based on machine learning approaches.
Section-IV	This section explored the complex stages of drug discovery, its trial over patients, and how machine learning algorithms can optimize this time-consuming process.
Section-V	This section investigated the side effects of surgery on patients' health, risks, machine learning-assisted surgical operations, etc.

VII. CONCLUSION

This paper reviewed issues and challenges associated with the AI and machine learning tools. Various researchers recognized the potential of these tools and contributed their efforts to build the modern healthcare system. It includes various perdition models that can be used to predict readmission, hypertension, heart diseases/cancer symptoms, the health status of elderly patients' mental disorders, anomaly status, patient dissatisfaction after surgical operations, children's health care, and malnutrition level. Machine learning schemes can be integrated with traditional decision support systems, and practitioners can utilize the existing datasets as benchmarks for training, validation, and diagnosis. Machine learning algorithms can be used to identify the disease behavior of the patients as well as the reaction of drugs to the patient's health. Automated drug trials can reduce the overall drug development cost, and drug trials can be performed without using live entities (human/animal). Machine learning tools can also be used to assist surgeons during operations. These can also be used to analyze the side effects of these operations on patient health, and complications associated with different surgeries can be predicted in advance to minimize the risk level. Patient feedback can be used to refine the diagnosis process. In the future, a machine learning framework will be developed to improve healthcare services.

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