

A COMPREHENSIVE REVIEW OF MACHINE LEARNING AND DEEP LEARNING ALGORITHMS IN HEALTHCARE

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Abstract—Machine learning and Deep learning algorithms have recently made significant contributions to the healthcare sector. This review paper's major goal is to expose effective health care analysis algorithms and methods. Numerous studies have demonstrated the high effectiveness of machine learning and Deep learning algorithms for healthcare analysis. The aim of this study is to give readers all the information they need to know about Machine learning and Deep learning algorithms utilised in the healthcare industry. In order to find out the efficient algorithms to predict the diseases a systematise survey have been conducted with various research articles related to health care sector using Machine learning and Deep learning algorithms. A list of the top machine learning and deep learning algorithms that accurately forecast diseases in the medical area is produced as a result of this effort, helping patients improve their quality of life. With the use of this output, researchers and professionals will understand the contributions that Deep learning and Machine learning algorithms have made to the field of health care, as well as how accurate these algorithms are in a single publication. In order to generate accurate predictions based on useful datasets, this research reviews concluded that the current research directions and potential implementation of efficient Machine learning and Deep learning in the medical industry

Keywords— *Machine learning, Deep Learning, Healthcare, Disease, Heart, Liver, Diabetics, breast cancer.*

I. INTRODUCTION

Modern day health care analysis relies heavily on machine learning (ML) and deep learning (DL) methods. The ML and DL algorithms are typically infused with logic and mathematics to make simple predictions from a given dataset. Machine learning algorithms can easily diagnose difficult diseases and raise the standard of care. Numerous studies on the use of ML and DL algorithms in healthcare for disease prediction have been conducted. Thousands of researchers around the world have made significant advancements in the detection of numerous diseases by using deep learning and machine learning algorithms.

Machine learning has the ability to forecast future data or provide a preferable conclusion from a dataset. It is frequently able to direct machines to carry out activities by taking into account patterns of where they should be done. Machine learning, which uses a dataset, is unquestionably a very practical technical application. Health care analysis is made possible by the use of ML and DL, which apply a number of probabilistic and optimization techniques.

Understanding what machine learning is and which machine learning techniques are frequently employed in disease detection is important for the examination of machine learning approaches. Artificial intelligence covers machine learning, which contains a number of methods for making statistical and probabilistic judgements based on prior knowledge. It classifies new events and forecasts new patterns using prior learning (training). Comparing machine learning to conventional statistical tools reveals how powerful it is. To get successful outcomes in machine learning, it is essential to have a thorough understanding of the problem at hand as well as the algorithmic limits. In light of this, if an experiment is properly carried out, training is carefully and effectively used, and results are vigorously validated.

These ML and DL methods, however, differ from human brains in both structure and functionality. They are incompatible with the findings of neuroscience due to these disparities. Convolutional neural networks (CNN), deep learning (DL) networks, recurrent neural networks (NN), and deep belief networks are DL architectures that have been used in a variety of research fields, such as speech recognition, computer vision (CV), audio recognition, language manipulation, machine translation, social media site filtering, drug design, bioinformatics, processing of medical images, board game programmes, and material analysis. These cutting-edge Learning algorithms have produced outcomes comparable to, and in some cases superior to, those of humans.

Since there is so much material dispersed over numerous papers, if some researchers want to understand machine learning algorithms, what is the diagnostic prediction accuracy, and which algorithms are the best across all papers, they typically become tired of searching for publications. Since there are many diseases and several algorithms, it might be very difficult to determine which algorithm is ideal for diagnosis. In fact, most of the time, they are unable to determine the precise paper. This work offered a review of the literature on several machine learning algorithms for accurately predicting diseases, which is discussed in other papers.

II. RELATED WORK

Machine learning and deep learning algorithms can predict disease quickly. But much of the paper has researched some specific diseases, and after implementing machine learning algorithms, they have shown that machine learning algorithms can predict diseases [1][2]. A study paper has shown the machine learning algorithms definition, and brief about some machine learning algorithms and one of the top algorithms has also shown for a specific disease [3]. Another study performing analysis of a machine learning algorithm on diabetes, they used a big dataset and apply some machine learning algorithm for predicting diabetes and show the best algorithms for diabetic's prediction [4]. Another study surveyed the prediction of diseases using a machine learning algorithm, they have shown the best algorithms [5]. Another study shows the best algorithms for liver diseases prediction [6],[7]. A study created a dataset and from that, they are applying some approach and method to predict breast cancer. It also shows which algorithms can predict breast cancer and only prediction of breast cancer was identified [8]. Different papers have predicted the heart disease [9] (Table 1).

Table 1: Machine learning and deep learning algorithms for health care analysis

S. No.	Title	Author	Publisher & Year	Abstract	Future work
1	Prediction of Liver Disease using Rprop, SAG and CNN	Deepa H Belavigi et al.,	International Journal of Innovative Technology and Exploring Engineering (IJITEE),2019	Rprop, SAG and CNN algorithms employed for predicting Liver Disease. The results of the models are compared and the accuracy is obtained	The developed algorithm on the hardware platform is ported to make it more useful and GUI can be created
2	Prognosis of Liver Disease: Using Machine Learning Algorithms	Vyshali J Gogi and MN Vijayalakshmi, 2018	IEEE, 2018	MATLAB2016 is used in this paper for implementing classification algorithm on the dataset. Linear Discriminant algorithm showed the highest prediction accuracy 95.8% and ROC is 0.93.	Research is proposed for considering the tumor characteristics of the patient once he is diagnosed with liver disorder.
3	Liver Disease Classification using Deep	L. Anand and V. Neelananarayanan	International Journal of Innovative Technology	The proposed methodology uses extracted features using M-PSO and ANN for	The exhibition of characterization of liver based ailments will additionally

	Learning Algorithm		and Exploring Engineering (IJITEE), 2019	classifying the features. The ANN methodology improves the accuracy. This paper focuses classification of selected features for classification.	improve by utilizing advancement systems and diagnosing the various sorts of liver sicknesses.
4	Prognosis of Diseases Using Machine Learning Algorithms: A Survey	N. Marline Joys Kumari and Krishna Kishore K.V.,	IEEE, 2018	The importance of big data analytics in health care among different applications where machine learning algorithms are implied.	The contribution made by many researchers for application of different machine algorithms along with accuracy is comparatively shown.
5	Breast Cancer Prediction using Deep learning and Machine Learning Techniques	Tiwari Monika and Bharuka Rashi and Shah Praditi and Lokare Reena	SSRN, 2020	The deep learning models give better accuracy compared to machine Learning Algorithms. Also the output is predictable in terms of probability in deep learning using Activation functions, which was not possible with machine learning algorithms	In future, these techniques may be implemented on datasets that consist of images. The accuracy of the model created may be increased in order to give better predictions.
6	Combined Deep CNN: LSTM with a Random Forest Approach for Breast Cancer Diagnosis	Almas Begum, V. Dhilip Kumar, Junaid Asghar, D. Hemalatha and G. Arulkumaran,	Complexity, 2022	The experimental results show that the proposed system accomplishes 100% of accuracy, a sensitivity of 99%, recall of 99%, and an F1-score of 98% compared to other traditional models. As the system achieved correct results, it can help doctors to investigate breast cancer easily.	The proposed model mentioned above has certain weaknesses. Sufficiently labelled data and an uneven number of classes are two of the most common problems. The absence of labelled data causes the models to provide biased findings, The, data augmentation approaches are required to handle issues and generate efficient categorization.
7	Prediction of Heart Disease Using Classification Algorithms	Hlaudi Daniel Masethe, Mosima Anna Masethe.	Proceedings of the World Congress on Engineering and Computer	Data mining algorithms such as J48, Naïve Bayes, REPTREE, CART, and Bayes Net are applied in this research for predicting	The classification accuracy can be improved by incorporating some techniques in the existing algorithms.

			Science, 2014	heart attacks. The research result shows prediction accuracy of 99%.	
8	Genetic Neural Approach for Heart Disease Prediction	Nilakshi P. Waghulde, Nilima P. Patil	International Journal of Advanced Computer Research, 2014	A Heart Disease Prediction System is developed using Neural Network and Genetic Algorithm. This system calculates the number of hidden nodes for neural network which train the network with proper selection of neural network architecture and uses the global optimization of genetic algorithm for initialization of neural network.	With the help of data mining algorithms, the classification performance increases. This can be further enhanced and expanded with more prediction algorithm for major life threatening diseases.
9	Prediction of Heart Disease Using Rnn Algorithm,	Sowri Raja Pillai, N., K.Kamurunissa Bee, J.Kiruthika.	International Research Journal of Engineering and Technology (IRJET), 2019	Prognosis prediction using RNN (PPRNN). The proposed PP-RNN uses multiple RNNs for learning from diagnosis code sequences of patients in order to predict occurrences of high-risk diseases. Finally our experimental result shows our proposed method can achieve more accuracy result.	In future more work will be done in this field so to improve the treatments and the lifetime of patient by properly maintaining and analyzing the health sector data.
10	Performance Analysis of Machine Learning Algorithms on Diabetes Dataset using Big Data Analytics	P Suresh Kumar and S Pranavi,	IEEE, 2017	A comprehensive study is done on diabetes dataset with Random Forest (RF), SVM, k-NN, CART and LDA algorithms. The achieved results shows that RF is giving more accurate predictions with compared to other algorithms.	Hybrid model can be developed to improve the classification accuracy.
11	Diabetes Prediction: A Deep Learning Approach	Safial Islam Ayon, Md. Milon Isla	Information Engineering and Electronic Business, 2019	The results on PID dataset demonstrate that deep learning approach design an auspicious system for the prediction of diabetes	Improving the classification accuracy by incorporating the theory like fuzzy set

				with prediction accuracy of 98.35%, F1 score of 98, and MCC of 97 for five-fold cross-validation..	and Dempster shafer theory.
12	Deep learning approach for diabetes prediction using PIMA.,	Naz, H., and Ahuja, S.	Springer, 2020	The outcome of the study confirms that DL provides the best results with the most promising extracted features. DL achieves the accuracy of 98.07% which can be used for further development of the automatic prognosis tool. The accuracy of the DL approach can further be enhanced by including the omics data for prediction of the onset of the disease.	In the future, we intend to develop a robust system in the form of an app or a website that can use the proposed DL algorithm to help healthcare specialists in the early detection of diabetes.

We studied all the details and taken the best algorithm in the disease prediction. It is difficult to find out all the topmost algorithm in one compilation. Therefore, we have chosen to conduct a survey paper in which the best algorithms are organized. In the future, if someone wants to do research machine learning algorithms in the field of healthcare they can get all the information together which saves significant research time.

A significant amount of research has already been carried in the prediction of various diseases. Let us now briefly review some of the important and relevant work done by various research groups in this area.

III. RESEARCH METHODS

This review paper represents the contribution of Machine learning and Deep learning algorithms in the healthcare sector to achieve the efficient algorithm for healthcare analysis. The key research publications in the area from 2010 to 2022 have been reviewed. The publications from the best publishers, including IEEE, Elsevier, MDPI, Nature, Science Direct, ACM, Springer, and Google Scholar, were the main focus. We have reviewed more than 200 papers on various machine learning and deep learning algorithms in health care prediction. The selected papers were analysed and reviewed for efficient algorithms for liver disease, heart disease, breast cancer and diabetics mellitus. Some of the research paper excluded which does not summarize the aim of this research paper.

IV. OBJECTIVES OF THE RESEARCH WORK

- To survey the machine learning and deep learning algorithms for health care analysis from various research article, proceedings and etc.,
- To identify the role of machine learning and deep learning algorithms in health care industry.
- To analyse various machine learning and deep learning algorithms with accuracy.
- Evolving most promising classifiers from the existing work.
- To find efficient machine learning and deep learning algorithms for health care analysis.

V. ANALYSIS OF EFFICIENT ALGORITHMS

Machine learning and Deep learning in disease diagnosis

To do the analysis, a data-set has been created with machine learning algorithms accuracy for diagnosis. From the dataset same graph have been made for each disease where the machine learning

algorithm's accuracy for diagnosis is available. So that researchers can easily find out which algorithms are best for diagnosis. Their accuracy has been described consecutively. Total of 4 diseases (liver disease, heart disease, breast cancer and diabetics mellitus) and more than 20 algorithms found in that dataset. Each paper has different accuracy through different tests but we have taken the best from there. For each disease, the topmost algorithms that have provided the best accuracy was presented in graph.

A. Liver disease

The different machine learning model exhibited the accuracy like logistic regression (95.8%) [7], Decision tree (94.9%) [7], Fuzzy Neural network (91%) [10], Support Vector machine (82.7%) [7],[11].

In addition, some of the deep learning algorithms are also employed and have given the better accuracy in liver disease prediction like Resilient Back Propagation Neural Network (69.41%) [6], Stochastic Average Gradient (SAG) (68.82%) [6], Convolutional Neural Network (96.17%) [6], Artificial neural network (95.41%) [12].

Among the above mentioned classification algorithms the deep learning algorithm Convolutional Neural Network (96.17%) is efficient for liver disease prediction (Figure 1).

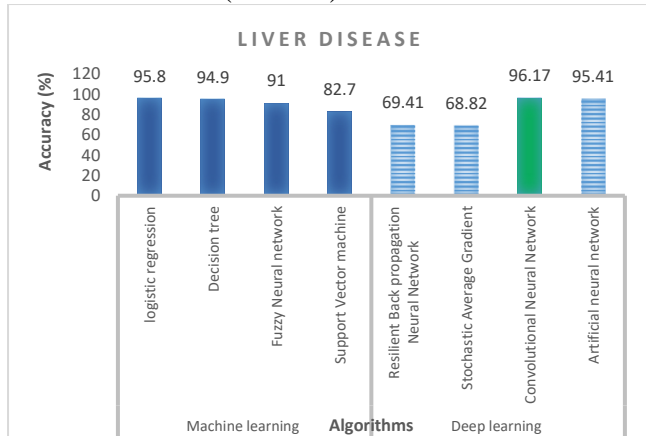


Fig. 1. Most promising ML and DL Algorithms in Liver disease prediction

B. Breast cancer

The different machine learning model exhibited the accuracy like Support Vector machine (99, 98.8%) [5] [8], Adaptive boosting (98.5%) [13], Classification and regression tree (98.50%) [14], J48 Algorithm (98.10%) [14], and Artificial Hydrocarbon Networks (97.8%) [15].

In addition, some of the deep learning algorithms are also employed and give the better accuracy in Breast cancer prediction like Convolutional Neural Network (98%) [16,17], Artificial neural network (99%) [18]. Combined Convolutional Neural Network with Random Forest (100%) [19] and Recurrent Neural Network (97%) [20].

Among the above mentioned classification algorithms the deep learning algorithm Combined Convolutional Neural Network with Random Forest (100%) is efficient for Breast cancer prediction (Figure 2).

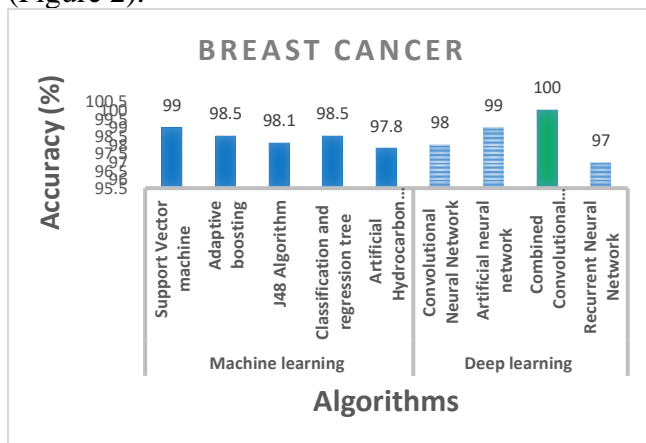


Fig. 2. Most promising ML and DL Algorithms in Breast cancer prediction

C. Heart disease

The various machine learning model exhibited the accuracy like Classification and Regression Tree (99.07%) [21], Genetic Neural Network (98%) [22], Fuzzy Neural Networks (97.7%) [23], Artificial neural network (97.5%) [24], Support Vector Machine (97.38%) [25], Decision Tree (91.4%) [26] and Naive Bayes (87.19%) [26].

In addition, some of the deep learning algorithms are also employed and give the better accuracy in Heart disease prediction like Recurrent Neural Network (98%) [27], Deep Convolutional Neural Networks (97%) [9], Convolutional Neural Networks (95%) [28], MLPNN with Back Propagation Algorithm (94%) [29], Deep Neural Networks (90.78) [30] and Multilayer Perceptron (MLP) (87.30%) [31].

Among the above mentioned classification algorithms the Machine learning algorithm Classification and Regression Tree (99.07%) is efficient for Heart disease prediction (Figure 3).

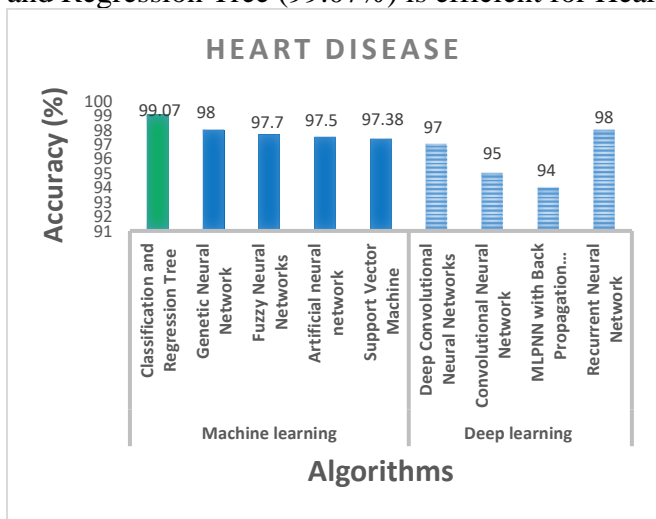


Fig. 3. Most promising ML and DL Algorithms in Heart disease prediction

D. Diabetic mellitus

The various machine learning model exhibited the accuracy like Random forest (100%, 98%) [3] [32], Support Vector Machine (96.9%) [3], Decision Tree (96.5%) [26], Naive Bayes (95%) [4] and Linear discriminant analysis (94.5%) [3].

In addition, some of the deep learning algorithms are also employed and give the better accuracy in Diabetic mellitus prediction like Deep Neural Network (98.35%) [33] (Safial Islam Ayon, Md. Milon Isla, 2019) Multilayer Feed Forward Network-Deep Learning (98.07%) [34], DNN Classifier (98.16%) [35] and Convolutional Long Short-term Memory (96.8%) [36].

Among the above mentioned classification algorithms the machine learning algorithm Random forest (100%) is efficient for Diabetic mellitus prediction (Figure 4).

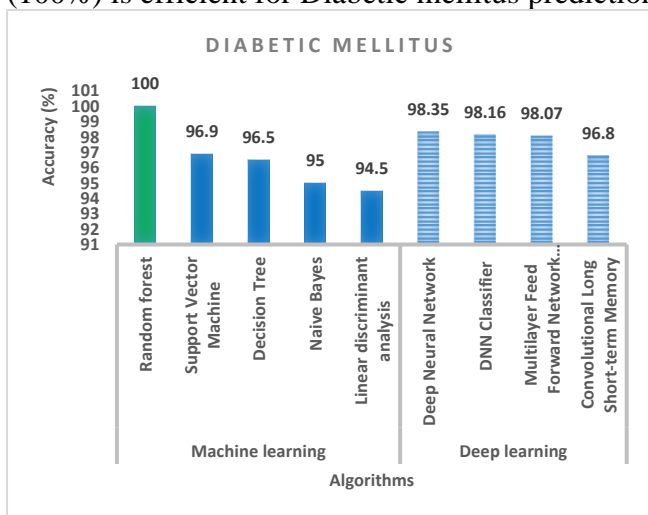


Fig. 4. Most promising ML and DL Algorithms in Diabetic mellitus prediction

VI. CONCLUSION

Researchers in machine learning and deep learning have made an effort to organise the data from all of the papers that include these techniques' contributions to healthcare. The top algorithms from all the papers we read have been compiled into a list. The technique described in the evaluated literature is not compromised in this article. We just paid attention to the algorithms utilised and how accurate they were. We think that the results of this study will aid practitioners and scientists in selecting the most effective algorithm to forecast the diseases included here. The most desirable accuracy for diagnosis from the data-set which implemented by the research work. We observed that 100 percent accuracy in deep learning algorithm for Breast cancer prediction and machine learning algorithm for Diabetic mellitus prediction.

REFERENCES

- [1] Van Pham, H.: A proposal of expert system using deep learning neural networks and fuzzy rules for diagnosing heart disease. In: *Frontiers in Intelligent Computing: Theory and Applications*, ed: Springer, 2020. pp. 189–198.
- [2] Nalluri, S.; Saraswathi, R.V.; Ramasubbareddy, S.; Govinda, K.; Swetha, E.: Chronic heart disease prediction using data mining techniques. In: *Data Engineering and Communication Technology*, ed: Springer, 2020. pp. 903–912.
- [3] Suresh Kumar, P and S Pranavi. Performance analysis of machine learning algorithms on diabetes dataset using big data analytics. In *2017 International Conference on Infocom Technologies and Unmanned Systems (Trends and Future Directions)(ICTUS)*, pages 508–513. IEEE, 2017.
- [4] Shailaja, K., B Seetharamulu, and MA Jabbar. Machine learning in healthcare: A review. In *2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, pp 910–914. IEEE, 2018.
- [5] Marline Joys Kumari, N and Kishore KV Krishna. Prognosis of diseases using machine learning algorithms: A survey. In *2018 International Conference on Current Trends towards Converging Technologies (ICCTCT)*, pp 1–9. IEEE, 2018.
- [6] Deepa H Belavigi, Veena G S, Divakar Harekal, Prediction of Liver Disease using Rprop, SAG and CNN, *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, ISSN: 2278-3075, Volume-8 Issue-8, June, 2019. pp 3290-3294.
- [7] Vyshali J Gogi and MN Vijayalakshmi. Prognosis of liver disease: Using machine learning algorithms. In *2018 International Conference on Recent Innovations in Electrical, Electronics & Communication Engineering (ICRIEECE)*, pages 875–879. IEEE, 2018.
- [8] Alireza Osareh and Bitia Shadgar. Machine learning techniques to diagnose breast cancer. In *2010 5th international symposium on health informatics and bioinformatics*, pages 114–120. IEEE, 2010.
- [9] Awais Mehmood, Munwar Iqbal, Zahid Mehmood, Aun Irtaza, Marriam Nawaz Tahira Nazir and Momina Masood, Prediction of Heart Disease Using Deep Convolutional Neural Networks, *Arabian Journal for Science and Engineering*, 2020, pp 1-15. <https://doi.org/10.1007/s13369-020-05105-1>.
- [10] Leoni Sharmila, S., C Dharuman, and P Venkatesan. Disease classification using machine learning algorithms-a comparative study. *International Journal of Pure and Applied Mathematics*, 114(6):1–10, 2017.
- [11] Ajay, S Singh, Md Irfan, Abhishek Chowdhury, et al. Prediction of liver disease using classification algorithms. In *2018 4th International Conference on Computing Communication and Automation (ICCCA)*, pp 1–3. IEEE, 2018.
- [12] Anand, L., V. Neelananarayanan, Liver Disease Classification using Deep Learning Algorithm, *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, ISSN: 2278-3075 (Online), Volume-8 Issue-12, 2019, pp 5105-5111.
- [13] Pahulpreet Singh Kohli and Shriya Arora. Application of machine learning in disease prediction. In *2018 4th International Conference on Computing Communication and Automation (ICCCA)*, pages 1–4. IEEE, 2018.

- [14] Padmapriya, B. and T. Velmurugan, "Classification algorithm based analysis of breast cancer data," *International Journal of Data Mining Techniques and Applications*, vol. 5, no. 1, pp. 43–49, 2016.
- [15] Hiram Ponce and Ma de Lourdes Martinez-Villasenor. Interpretability of artificial hydrocarbon networks for breast cancer classification. In *2017 International Joint Conference on Neural Networks (IJCNN)*, pages 3535–3542. IEEE, 2017.
- [16] Naresh Khuriwal and Nidhi Mishra. Breast cancer diagnosis using adaptive voting ensemble machine learning algorithm. In *2018 IEEMA Engineer Infinite Conference (eTechNxT)*, pp 1–5. IEEE, 2018.
- [17] Naresh Khuriwal, Nidhi Mishra, "Breast cancer detection from histopathological images using deep learning," *3rd International Conference and Workshops on Recent Advances and Innovations in Engineering*, 22-25 November 2018.
- [18] Tiwari Monika and Bharuka Rashi and Shah Praditi and Lokare Reena, *Breast Cancer Prediction Using Deep Learning and Machine Learning Techniques (March 22, 2020)*. Available at SSRN <http://dx.doi.org/10.2139/ssrn.3558786>. pp 1-5.
- [19] Almas Begum, V. Dhilip Kumar, Junaid Asghar, D. Hemalatha and G. Arulkumaran, *A Combined Deep CNN: LSTM with a Random Forest Approach for Breast Cancer Diagnosis*, *Hindawi Complexity*, 2022, pp 1-9.
- [20] Sangapu Venkata Appaji, R. Shiva Shankar, K.V.S. Murthy and Chinta Someswara Rao, *Breast Cancer Disease Prediction With Recurrent Neural Networks (RNN)*, *International Journal of Industrial Engineering & Production Research*, 2020, Vol. 31, No. 3: pp379 -386.
- [21] Hlaudi Daniel Masethe, Mosima Anna Masethe. "Prediction of Heart Disease Using Classification Algorithms", *World Congress on Engineering and Computer Science 2014*, ISBN: 978-988-19253-7-4.
- [22] Nilakshi P. Waghulde, Nilima P. Patil. "Genetic Neural Approach for Heart Disease Prediction", *International Journal of Advanced Computer Research*, 2014. Volume-4 Number-3 Issue-16.
- [23] Kaan Uyar and Ahmet Ilhan. Diagnosis of heart disease using genetic algorithm based trained recurrent fuzzy neural networks. *Procedia computer science*, 120:588–593, 2017.
- [24] Debabrata Swain, Santosh Kumar Pani, and Debabala Swain. A metaphoric investigation on prediction of heart disease using machine learning. In *2018 International Conference on Advanced Computation and Telecommunication (ICACAT)*, pages 1–6. IEEE, 2018.
- [25] Zhang Et Al., "Studies on Application of Support Vector Machine in Diagnose of Coronary Heart Disease", *Electromagnetic Field Problems and Applications 2012 Sixth International Conference (ICEF)*, 2012, Dalian, IEEE.
- [26] Mung, P. S. and S. Phyu. Effective analytics on healthcare big data using ensemble learning. In *2020 IEEE Conference on Computer Applications (ICCA)*, pp 1–4, 2020.
- [27] Sowri Raja Pillai, N., K.Kamurunissa Bee, J.Kiruthika. "PREDICTION OF HEART DISEASE USING RNN ALGORITHM", *International Research Journal of Engineering and Technology*, Volume-06, Issue-03, 2019, pp 4452-4458.
- [28] Shubhanshi Singhal, Harish Kumar, Vishal Passricha, "Prediction of Heart Disease using CNN", *American International Journal of Research in Science, Technology, Engineering & Mathematics*, 2018, pp 257-261.
- [29] Sayad, A. T. and P. P. Halkarnikar. "Diagnosis of Heart Disease Using Neural Network Approach", *International Journal of Advances in Science Engineering and Technology*, ISSN: 2321-9009 Volume-2, Issue-3, 2014, pp 88-92.
- [30] Sumit Sharma, Mahesh Parmar, "Heart Diseases Prediction using Deep Learning Neural Network Model", *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Volume-9 Issue-3, 2020, pp 2244-2248.
- [31] Sakshi Bhoyar, Nikki Wagholikar, Kshitij Bakshi and Sheetal Chaudhari, "Real-time Heart Disease Prediction System using Multilayer Perceptron", *2nd International Conference for Emerging Technology (INCET)*, 2021. pp1-4.

- [32] Shweta Ganiger and KMM Rajashekharaiiah. Chronic diseases diagnosis using machine learning. In 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET), pp 1–6. IEEE, 2018.
- [33] Safial Islam Ayon, Md. Milon Isla, “Diabetes Prediction: A Deep Learning Approach” I.J. Information Engineering and Electronic Business, 2019, 2, 21-27 DOI: 10.5815/ijieeb.2019.02.03.
- [34] Naz, H., and Ahuja, S. (2020). Deep learning approach for diabetes prediction using PIMA., Indian dataset. *Journal of Diabetes & Metabolic Disorders*, 19(1), 391–403.
- [35] Bala Manoj Kumar P., Srinivasa Perumal R., Nadesh R K. and Arivuselvan K. “Type 2: Diabetes mellitus prediction using Deep Neural Networks classifier, *International Journal of Cognitive Computing in Engineering* 1 (2020) pp 55–61.
- [36] Bharath Kumar Chowdary, P. and R. Udaya Kumar, “An Effective Approach for Detecting Diabetes using Deep Learning Techniques based on Convolutional LSTM Networks”, *International Journal of Advanced Computer Science and Applications*, Vol. 12, No. 4, 2021, 519-525.