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Machine Learning Techniques for Brain Stroke using MRI

Mithun Sahani H S[1], Mounika B[2], N Vamshi[3], Maya B S [4]

[1,2,3]*Students of CSE, Bangalore Institute of Technology*
[4]*Maya B S, Assistant Professor, Dept. of CSE, BIT, V. V. Puram, Bangalore, Karnataka, India*

Abstract - Stroke is a neurological disease that occurs when a brain cells die as a result of oxygen and nutrient deficiency. Stroke detection within the first few hours improves the chances to prevent complications and improve health care and management of patients. In addition, significant effect of medications that were used as treatment for stroke would appear only if they were given within the first three hours since the beginning of stroke. Early and accurate diagnosis of stroke improves the probability of positive outcome. Machine Learning is a branch of artificial intelligence and is a field of computer science and engineering that facilitates extraction of data based on pattern recognition.. In this review, we offer an insight into the recent developments and applications of Machine Learning in neuroimaging focusing on brain stroke.

Key Words: **Neuroimaging, machine learning Artificial Neural Network(ANN), Decision Tree, Support Vector Machine(SVM).**

1. INTRODUCTION

A stroke is a medical condition in which poor blood flow to the brain results in cell death [7] .Stroke is currently the leading cause of disability and the fifth leading cause of death in the United States [1]. It is well established that early and accurate diagnosis improves outcome by increasing the probability of successful intervention. There are two main types of stroke: ischemic, due to lack of blood flow, and hemorrhagic, due to bleeding. Signs and symptoms of a stroke may include an inability to move or feel on one to another side of the body, problems understanding or speaking, dizziness, or loss of vision to one side. Diagnosis is typically based on a physical exam and supported by medical imaging such as a CT scan or MRI scan.

According to heart disease and stroke statistics update of 2015 [5], 11.13% of deaths globally were accounting for stroke. With 33 million affected persons, stroke is the second leading cause of death worldwide. Furthermore, it is the first leading cause of adult disability with 16.9 million affected persons [6].

Machine Learning (ML), considered a branch of artificial intelligence, is a field of computer science and engineering that facilitates extraction of data based on pattern recognition. A computer learns from previous mistakes after repeated analysis of data and masters tasks that were previously considered too complex for a machine to process [8]. The development of these systems to interpret data in neuroimaging has provided valuable information for research in matters of the interaction, structure, and mechanisms of the brain and behavior in certain neurological disorders [2].

Brain stroke diagnosis usually involves Magnetic Resonance Imaging and biopsy. MRI is preferred as it non-invasive. Though in some cases, MRI alone is not enough to determine the type of tumor, requiring a biopsy. The risk associated with biopsy is high and does not guarantee accurate results. The technicians performing these procedures have a great impact on the results, introducing the problem for human-error. There is a need for computer aided systems to assist doctors to make correct decisions. In recent years there has been a lot of research in this regard using various machine learning techniques. Before the advent of deep learning, feature selection techniques like Principal Component Analysis, Discrete Wavelet Transform and so on followed by classifiers like SVM, ANN and others are used. Now the primary focus is on utilizing neural networks to achieve more promising results.

2. Literature Review

Schizophrenia, et al. used Random Forest (RF), a machine learning algorithm, to discriminate between childhood-onset schizophrenia and healthy patients based on brain magnetic resonance imaging (MRI) measurements of regions of interest (ROI): left temporal lobes, bilateral dorsolateral prefrontal regions, and left medial parietal lobes. The algorithm correctly classified groups with 73.7% accuracy, and a greater brain-based probability of illness was associated with a statistically significant worse functioning and fewer developmental delays. Machine learning can also help distinguish between subsets of a certain disease. [4]

D.Shanthi et.al, Artificial Neural Networks (ANN) is used for the prediction of Thrombo-embolic stroke disease.This study uses the dataset of patients who have the symptoms of stroke disease. Backward stepwise method is used for input feature selection. Performance of neural network is achieved by removal of insignificant inputs. This research work demonstrates about ANN based prediction of stroke disease by improving the accuracy to 89% with higher consistent rate. The ANN exhibits good performance level for prediction of stroke disease [10].

Bleich-Cohen et al. utilized Searchlight Based Feature Extraction (SBFE), a data-driven multi-voxel pattern analysis (MVPA) approach, to search for activation clusters of cognitive loads in brain functional Magnetic Resonance Imaging (fMRI). This ML method helped to identify the two

subgroups of schizophrenic patients with and without Obsessive-Compulsive Disorder (OCD) with a 91% accuracy, successfully delineating between symptom severity and a psychiatric comorbidity[11].

Moghim et al., introduced a predictive model for seizure occurrence in a single patient. This approach was based on a multi-class support vector machine (SVM) and 14 selected features of an electro encephalogram in patients with epilepsy. The predicted time of seizure with a window between 20 and 25 min was reported with an average sensitivity of 90.15, 99.44% specificity, and 97% accuracy [12].

Lesion burden estimation in traumatic brain injury (TBI), AIS, dementia, and multiple sclerosis serve to identify the affected regions, the extent of damage, and therefore, the functional outcome in such patients. Kaminatas et al. [13] proposed an approach for lesion segmentation using a multi-modal brain MRI based on an 11-layers deep, multi-scale, 3D Convolutional Neural Networks (CNN) called Deep Medic. Their proposed novel training scheme is based on two main components, a 3D CNN that produces accurate soft segmentation maps and a connected Conditional Random Field that imposes regularization constraints on the CNN output and produces the final hard segmentation labels. This allows for a deeper and more discriminative delimitation of lesion burden, with the highest reported accuracy observed in a cohort of patients with severe TBI.

Decision support tools were the main outcome for many health-related data mining articles. Sheng-Feng Sunga, et al. [3] analyzed data of acute ischemic stroke patients to develop a prediction model for the severity of the disease. In their study, they used K-nearest neighbor model, multiple linear regression, and regression tree model, that resulted an accuracy of 0.743, 0.742, and 0.737, with 95% confidential interval.

Ahmet K. Arslan et al. [9] used three data mining algorithms, namely: Support Vector Machine (SVM), Stochastic Gradient Boosting (SGB) and penalized logistic regression (PLR) to predict stroke. SVM achieved an accuracy of 98% .

Leila Amini et al. [14], in addition, by using K-nearest neighbor and C4.5 decision tree, achieved an accuracy of stroke prediction equal to 94.2% and 95.4% respectively.

Shanthi et al [16], Artificial Neural Network (ANN) prediction model achieved a predictive accuracy of thrombotic stroke equal to 89% shown in his study. Stroke is being observed as a rapidly growing health issue in Saudi Arabia. Therefore, it becomes one of the health care issues in Saudi Araba. The lack of researches that focus on the role of technology, mainly KDD, in predicting of stroke in the Saudi Arabia, leads to this research

Deepak et.al [15], adopt the concept of transfer learning for feature extraction in the classification system. As pre-processing the MRI images were normalized and reduced to 224 x 224 pixels. A pre-trained GoogLeNet is modified to learn features from brain MRIs. The extracted features are tested on SVM and KNN classifier models along with the softmax layer of GoogLeNet. The classification accuracy of the deep transfer learned (standalone) model, SVM and KNN are 92.3%, 97.8% and 98% respectively.

Machine learning algorithms have been used to assist in the diagnosis and individualized treatment decisions in stroke. A summary of the most recent articles investigating the applications of machine learning for automated diagnosis of stroke is given in Table 1.

Table -1: Summary of Machine Learning techniques.

No	Author Name	Methods	Accuracy
1	Huang et al.	Supported vector machine	86%
2	Scalzo et al.	Non-linear regression model	85%
3	Deepak, et.al	SVM, NN, GoogleNet	92.3%, 97.8%, 98%
4	Takahashi et al.	SVM	97.5%
5	Forkert et al.	Multi-class SVM	85%
6	Asadi et al.	ANN	70%
7	Bouts et al.	Adaptive boosting	89.5%
8	Heba Mohsen, et.al	Fuzzy C Means, Discrete Wavelet Transform, Principal Component Analysis, Deep Neural Network	98.4%
9	Garima Singh, et.al	Naïve Bayes classifier, SVM.	87.23%, 91.49%
10	Sheng-Feng Sunga	Decision support	95%

3. CONCLUSION

Owing to the deadly nature of brain stroke, lot of research has been carried to automate its detection and classification. With the advancement in machine learning, neural networks have become the primary focus of interest in developing models for brain stroke diagnosis. There is a particular need for ML solutions in this field, which is faced with the challenge of increasingly complex data, with limited human expert resources. Future directions in Machine Learning for acute ischemic stroke may require collaborative approaches across multiple institutions to build a robust dataset for efficient training of machine learning networks. There is still a need for further research and enhancement of techniques in this regard to ensure that the developed systems can be deployed for use by doctors as second opinion to diagnose stroke.

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REFERENCES

[1] Alison E. Baird, "Genetics and Genomics of Stroke Novel Approaches" Brooklyn, New York Vol. 56, No. 4, 2010.

[2] UPMC Presbyterian: "A Designated Comprehensive Stroke Center what to expect recovery from stroke". www.UPMC.com/services/strokeinstitute. 2015.

[3] Sheng-Feng Sunga, et al. "Developing a stroke severity index based on administrative data was feasible using data mining techniques", Journal of Clinical Epidemiology, Volume 68, Issue 11, November 2015, Pages 1292–1300.

[4] Greenstein D, Malley JD, Weisinger B, Clasen L, Gogtay N.,"Using multivariate machine learning methods and structural MRI to clasify childhood onset schizophrenia and healthy controls", Front Psychiatry,Vol.53,Issue.3, 2012.

[5] Mozaffarian D, et al. on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. "Heart disease and stroke statistics (2015 update) a report from the American Heart Association", December 17, 2014.

[6] World health organization. The top 10 causes of death.http://www.who.int/mediacentre/factsheets/fs310/en/ .May 2014.

[7] Ho KC, Speier W, El-Saden S, Arnold CW, "Classifying acute ischemic stroke onset time using deep imaging features", In: AMIA Annual Symposium Proceedings (Washington, DC:)pp.892-901, 2017.

[8] Song X, Chen NK. "A unified machine learning method for task-related and resting state fMRI data analysis" Conference Proceeding IEEE Engineering Medical Biological Society, pp.6426-6429, 2014.

[9]Ahmet K. Arslana, Cemil Colaka, and Ediz Sarihanb.,"Different Medical Data Mining Approaches Based Prediction of Ischemic Stroke. Computer Methods and Programs in Biomedicine", March 2016

[10]D.Shanthi,Dr.G.Sahoo,Dr.N.Saravanan,"Designing an Artificial Neural Network Model for the Prediction of Thrombo-embolic Stroke", IJBB, Volume 3. pp.10-18, 2016.

[11]Bleich-Cohen M, Jamshy S, Sharon H, Weizman R, Intrator N, Poyurovsky M, et al. "Machine learning fMRI classifier delineates subgroups of schizophrenia patient", Schizophr Res. Vol.160,pp.196–200, 2014.

[12]Moghim N, Corne,"DW: Predicting epileptic seizures in advance", PLoS ONE (2014).

[13] Kamnitsas K, Ledig C, Newcombe VFH, Simpson JP, Kane AD, Menon DK, et al. "Efficient multi-scale 3D CNN with fully connected CRF for accurate brain lesion segmentation" Journal on Medical Image Analytics, Vol.36, pp.61-78,2017.

[14] Leila Amini, et al.,"Prediction and Control of Stroke by Data Mining", International journal of preventive Medicine, pp. 245-249,2013.

[15] Deepak, P.M. Ameer, "Brain stroke classification using deep CNN features via transfer learning", Elsevier, Computers in Biology and Medicine 111, pp 1-7, 2019.

[16] D.Shanthi,,et al. "Designing an Artificial Neural Network Model for the Prediction of Thromboembolic Stroke", IJBB, Volume 3. pp.10- 18, 2008,

[17] Eibe Frank, Mark A. Hall, and Ian H. Witten "The WEKA Workbench. Online Appendix for "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Fourth Edition, 2016.