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Intelligent Decision Support System for Medical Image Analysis Using Machine Learning

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Abstract: Extensive studies are being conducted to determine the efficacy of using machine learning techniques in the medical field. Disease recognition from many data sources and modeling human-like behavior or thought processes are its primary focuses. Medical data that may be utilized to assist choices in the field of medicine has been routinely collected and stored thanks to recent advancements in computers and innovations in technology. But initially, digital patient data collection and organization is required in most nations. After data collection, diagnostics, signal/image analysis, prediction, and treatment planning are required to arrive at a medical conclusion. Artificial Neural Network (ANN) computing and Support Vector Machines (SVM) are two machine learning techniques that have shown effective in tackling problems of this complexity. The paper includes a study of intelligent approaches for medical decision making that intends to explore and illustrate their potential in this setting.

***Keywords**: Artificial Neural Networks (ANNs), Support Vector Machines (SVM), Intelligent methods, complex tasks*

1. Introduction

The term "machine learning" (ML) is used to describe the evolution of computer programs that carry out AI-related activities (Nilsson 1996). Parameters are used to create the ML model, and then training data is used to improve those parameters. The model may either make predictions or provide descriptions. If the model is predictive, it uses the available data to create forecasts about the future. A descriptive model learns from the data it is given. Machine learning is particularly useful since it streamlines and simplifies the time-consuming process of analyzing massive datasets and deriving actionable insights from them. Machine learning methods may be categorized as either supervised, unsupervised, or reinforced. Many different industries may benefit from the use of Machine Learning methods, including those dealing with voice recognition, computational biology,.

Artificial Neural Network (ANN)

An ANN is a computer model built from several connections between elementary processing units (neurons). ANN mimics the functioning of the human nervous system. It employs the capabilities of biological neurons to address challenging, real-world challenges. There are two distinct categories of ANN based on their structure: single-layer and multi-layer networks. For issues that can be neatly divided along a single axis, use a single-layer neural network; for more complex problems, use a multi-layer network. To address the issue of character recognition, Rosenblatt first presented the single layer perceptron in 1958. The environment provides input to the single layer perceptron. The input feature values and their associated weights are multiplied together to form the net input. The single-layer perceptron's output is determined by the threshold value. A single-layer network's main flaw is that it produces predictable results that mirror the input pattern. Many real-world issues have multiple solutions for seemingly identical input patterns (FFNN, 2010). It is common practice to include one or more hidden layers between the input and output layers of a neural network in order to address nonlinearly separable issues of high complexity. Multi-Layer Perceptron (MLP) is the name given to this specific neural network design. The MLP's hidden layer handles nonlinear connections between the input and output layers.

Feed Forward Neural Network

After each layer of a multilayer perceptron conducts a certain processing on the information it has received, the results of that processing are then transferred on to the next layer to be processed. Neurons in the input layer have their values for the features in the dataset hardwired into them so that they may be learnt from. The

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dimensions of the input layer, which is expressed as the number of neurons, is proportional to the quantity of input characteristics that are included in the dataset. The output of each neuron in the hidden layer and the output layer is equal to the product of the scores of the neurons in the layer below it. This is true for both layers. The activation function of a neuron will tell you all you need to know about its capabilities. The functions for activating are used not only in the hidden layer, but also in the output layer. In contrast to the nonlinear activation function that is used by the hidden layer, the output layer makes use of a linear activation function. In response, the artificial neural network generates a number that indicates the degree of fine-tuning of its parameters that is required. The median square error is a useful statistic for figuring out how much of a modification should be made to the weights that are utilized in the network. Training refers to the method whereby the network is able to make these kind of modifications.

Backpropagation (BP) algorithms

In 1986, Rumelhart presented the BP algorithm. The ANN may be trained with the help of the supervised learning algorithm BP. Weights are initially set, MSE is calculated, weights are optimized, and mistakes are backpropagated throughout BP training. There are two distinct categories of BP training algorithms: rapid and slow. Both heuristic and traditional numerical optimization come under the umbrella of quick training techniques. Analyzing the efficiency of the classic steepest descent technique allows for the development of heuristic methods. Heuristic methods are further classified as either Gradient Descent BP (which uses a fixed learning rate) or Resilient BP (which uses a variable learning rate). Conjugate Gradient, Quasi Newton, and Levenberg-Marquardt are the three main categories of the conventional numerical optimization methods. There are four subtypes of Conjugate Gradient algorithms: those that use Fletcher-Reeves updates, those that use Polak-Ribiere updates, those that use Powell-Beale Restarts, and those that use Scaled Conjugate Gradient. Both the BFGS method and the One Step Secant algorithm fall within the category of Quasi Newton algorithms. Gradient descent methods, which are employed for training, are too time-consuming to be useful for tackling real-world issues. Both an incremental and a batch mode exist for the gradient descent techniques. After each new input is fed into the network, the gradient is calculated and the weights are adjusted in incremental training mode. Training in the batch mode involves applying all inputs at once before updating the network weights. Training BPs relies heavily on network settings and methods.

ANN parameters

ANN parameters needed to train BPNN include starting weights and biases, the number of hidden layers, the the length of neurons in each hidden layer, the function for activation, the number of training iterations, the learning rate, the minimum error, and the momentum term. Initial weights and biases are also required. By picking the initial weights and biases with care, it is possible to shorten the amount of time required for a neural network to train and to improve the accuracy of its predictions right away. Using a hidden layer, a problem that cannot be separated linearly may sometimes be split down into components that are more straightforward. When accuracy is the key objective, and there are no limits on complexity of networks or training time, several hidden layers and a high number of neurons in the hidden layer are employed. The term "learning rate" refers to the rate at which the network's weights and biases are changed when it is being trained. The system does not allow itself to reach a stable minimum because of a parameter known as momentum. The activation function is responsible for determining not only how complex the network is but also how effective it is. It is essential in order for the learning algorithms to converge. If the network is not properly designed, the training process will move at a more glacial pace.

Need For Hybrid Intelligent Systems

An intelligent system may adapt to its surroundings and enhance its own performance over time. The intelligent system is not only capable of learning, adapting, surviving failure, and organizing itself, but it can also handle uncertainty. The smart system has the ability to learn and also conducts tasks like search and optimization. Data processing, medical care, business, and finance are just few of the many fields that use intelligent systems. By working together, search and learning are able to overcome their own weaknesses and unleash their combined potential. The local minima issue in ANN classification has prompted researchers to integrate neural network approaches with other methods. Researchers use neural network hybridization with other heuristic or metaheuristic techniques for efficient classification, such as the Genetic Algorithm (GA)

2. Literature Review

Vikas Kamra et.al (2019) The ever-increasing patient load at our nation's hospitals is a direct result of our population boom. As a result, we have an immediate need for cutting-edge technology that enhances the efficiency of our medical diagnostics system. Both hospitals and their patients will benefit from this technological advancement. It helps hospitals save time and money by decreasing the likelihood of human mistake during patient registration. It also helps people

spend less time in hospitals, money, and energy overall. Patients may monitor their own health at regular intervals with this technology. Patients may get risk alerts depending on their specific medical symptoms with the help of this technology. Because there is now a wealth of data that may be used in the diagnosis of a wide range of illnesses. Data mining and machine learning methods may be used to this data to develop a diagnostic assistance system for the medical field. That A.I. can pick up new skills with the use of machine learning techniques. It analyzes existing medical data to come up with a smart way to diagnose illness. The primary function of the system is to aid in the process of making decisions during medical diagnosis. In this research, we provide a novel methodology for developing an ML-powered diagnostics assistant..

Maulana Miftakhul Faizin et.al(2017) In this article, we discuss how AI has been integrated into a medical decision support system to help doctors spot signs of dehydration in kids. In this research, a decision tree was built using the C4.5 algorithm and then pruned using the REP (Reduced Error Pruning) technique to create an intelligent system. The inclusion of AI in the medical decision support system yielded a 91% success rate and an error rate of just 0.085714286 percent. The findings suggest that medical decision support systems that include artificial intelligence may help with the diagnosis of childhood dehydration.

Parag Chatterjee et.al (2017) The Internet of Things (IoT) and decision support systems are the main topics of this article because of their potential to provide proactive and insightful medical treatment. This study has two goals: first, to outline the framework for an Internet of Things-based healthcare platform and decision support system that can help achieve the ideals of a technology-driven healthcare system; and second, to demonstrate said framework through its application to cardiovascular diseases and the identification of risk groups among a representative population.

Improved Fuzzy Association Rule Image Mining Algorithm For Medical Decision Support System

The key to effectively treating a patient with a brain tumor is on its early detection. Computerized tomography (CT) scans are utilized for diagnosis of brain tumors at an early stage. The neuroradiologist meticulously examines each CT scan picture for any anomalies. However, because to the various densities of cancer tissue structure, the abnormalities are often not obvious and are frequently entrenched. However, estimations show that the radiologist may overlook anywhere from 10% to 30% of tumor cells during the standard screening. Therefore, many different types of computer assisted diagnostic systems are considered in order to optimize screening techniques. Classifying brain CT scans led to the creation of the Improved Fuzzy Association Rule Mining (IFARM) technique. Fuzzy Association Rule employs a fuzzy logic system to translate between the two types of characteristics, numerical and fuzzy. In the field of fuzzy association rule mining, the Fuzzy apriori approach is now the most often used algorithm. The technique is useful for identifying patterns of knowledge in a medical CT scan picture collection. It helps streamline the mining process by focusing on what's really important.

Combining Association Rules Mining with a Decision-Tree Algorithm to Create a Hybrid Classification System for Medical Images

Tumors of the brain, or intracranial tumors, may be either malignant (cancerous) or benign (noncancerous). The goal of mining is to automatically develop all high-impact patterns without any human intervention. Large picture databases have been used for rule mining. Combining picture libraries with their metadata has allowed for mining to take place. Image mining relies on matching together photos that include similar items. Segmentation and the elimination of irrelevant material from a picture using the Watershed morphological transformation have been detailed. One of the most crucial processes in image processing is feature extraction. Most studies have employed association rule mining to discover diagnostic rules in both big and small datasets. The FP-Tree technique was utilized to establish the rule of association in this paper. Extracted image categorization and decision tree building may be a powerful diagnostic tool. Standardized on the frequent-pattern growth algorithm, ARM is effective in mining big datasets that exhibit frequent patterns. The brevity and comprehensiveness of it are the keys to its success. No more need to construct candidate item sets thanks to its tree-like representation of the whole collection of transactions and patterns.

3. Experimental Results

Experiments were performed using a dataset of CT scans of the brain. The resulting graphic is displayed in Figure 1. Medical professionals' databases of pre-diagnoses are taken into account. The CT brain image's edge feature has been identified using a median filtered approach. Additionally, speckle sounds may be filtered out using this filter. The average filtered CT scan of the brain is shown in Figure 2.

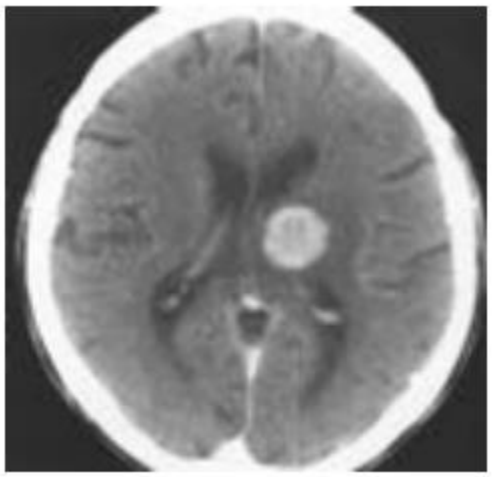

Fig 1 Input sample CT scan brain image

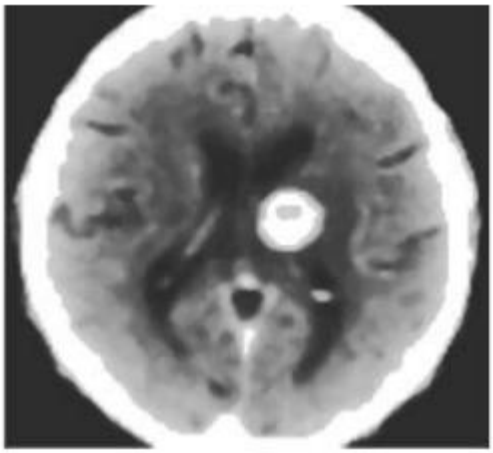

Fig. 2 Median filtered CT scan brain image

Table 1. Classification of brain tumor with association rule and decision tree classification

Categories	Physician classification			Association rule with decision tree classification		
	Benign	Malignant	Normal	Benign	Malignant	Normal
Benign	TN 50	FN 2	TP 30	TN 66	FN 1	TP 30
Malignant	FP 10	TN 28	TP 20	FP 4	TP 29	TP 20
Normal	TP 5	TP 5	TP 10	TP 5	TP 5	TP 10
Total	65	35	60	65	35	60

4. Conclusion

In this research, we construct and analyze a brain tumor classification system based on an association rule and a decision tree approach as part of an Intelligent Decision Support System. Speckle noises in CT scans of the brain are effectively reduced by using the median filtering method. The cells of a brain tumor may be effectively classified using the suggested hybrid technique of association rule mining and decision tree algorithm. If

you compare the suggested approach to the current classifiers, you'll find that it excels. Classifying brain tumors was shown to have a sensitivity of 97%, specificity of 96%, and accuracy of 95%. Medical professionals may perhaps benefit from the established brain tumor categorization system.

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