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PREDICTION OF BRAIN TUMOR USING MACHINE LEARNING

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Abstract— "Prediction of Brain Gliomas using Machine Learning algorithm" is an innovative project aimed at developing an online diagnostic prediction page that utilizes machine learning algorithms and medical data to diagnose various types of brain Tumor whether it's an initial stage or at final stage. The system will be designed to assist medical practitioners in making accurate and timely diagnoses by analyzing patient data, such as medical history, symptoms, and test results. This project aims to improve healthcare outcomes by increasing the accuracy of diagnoses. The proposed system will be user-friendly, secure. Additionally, it will be scalable, making it suitable to use for the patients. The project has the potential to revolutionize the field of medical diagnosis and significantly improve patient outcomes. This can also be helpful for the patients to find out the disease related to Brain Tumor. Magnetic resonance imaging (MRI) is a very useful method for diagnosis of tumors in human brain. In this paper, brain MRI images have been analyzed into three different categories: Meningioma, glioma, & pituitary.

Keywords: Machine Learning (ML), Brain Tumor, Convolutional Neural Network (CNN), Magnetic Resonance Imaging

I. INTRODUCTION

The "Prediction of Brain Gliomas using Machine Learning Algorithm" is a Brain Tumor diagnosis system is designed to help patients accurately diagnose medical conditions based on symptoms and other relevant information. The system utilizes machine learning based Logistic Regression method to analyze patient data, including medical histories, and symptom descriptions. By comparing this information with a vast database of medical knowledge and previous diagnoses, the system can suggest potential diagnoses with high accuracy and efficiency. The ultimate goal of this project is to improve the speed and accuracy of Brain Tumor diagnoses, leading to better patient's outcomes and more effective treatment plans. We hope that this system will be a valuable for patients.

The Brain Tumor diagnostic system is an essential prediction page that can help healthcare professionals or patient in many ways. It can save time and resources, reduce errors, and improve patient outcomes. The system can generate accurate diagnoses based on the patient's symptoms, medical history, and other relevant factors.
The previous approaches were:

- Diagnosing system with Supervised Learning methodology like CNN etc.
- Medical diagnosis using KNN of Supervised Learning
- Medical diagnosis using Decision Tree of Supervised Learning.

It is essential to promote early diagnosis of brain tumors because they are the most common cause of cancer-related deaths in children and people up to 40 years of age. Therefore, it is necessary to devise strategies to accelerate early diagnosis of brain tumors. An early diagnosis of brain tumor implies faster response in treatment, thereby increasing the surviving rates of patients. A process designed to automatically detect, locate and classify brain tumors is desirable. AI and ML have gained prominence in almost every field of decision-making and can be successfully implemented for the detection and classification of brain tumors. The objective of this paper is to investigate the use of ML classification algorithms to detect the presence of brain tumors and also distinguish between different types of brain tumors such as glioma, meningioma and pituitary tumors from brain MRI images. The proposed scheme involves a few steps including data collection, data preprocessing (data labeling and image pre-processing), classification based on enhanced ML techniques and finally a comparative analysis of the implemented models.

II. LITERATURE REVIEW

In recent years, there has been a growing interest in the use of machine learning algorithms for brain tumor prediction. Many researchers have proposed various approaches for the classification of brain tumor images, including supervised and unsupervised learning techniques.Supervised learning techniques involve the use of labeled data to train a machine learning model to classify brain tumor images. These techniques include logistic regression, decision trees, random forests, and support vector machines (SVMs). Many studies have shown that SVMs perform well in brain tumor classification tasks.

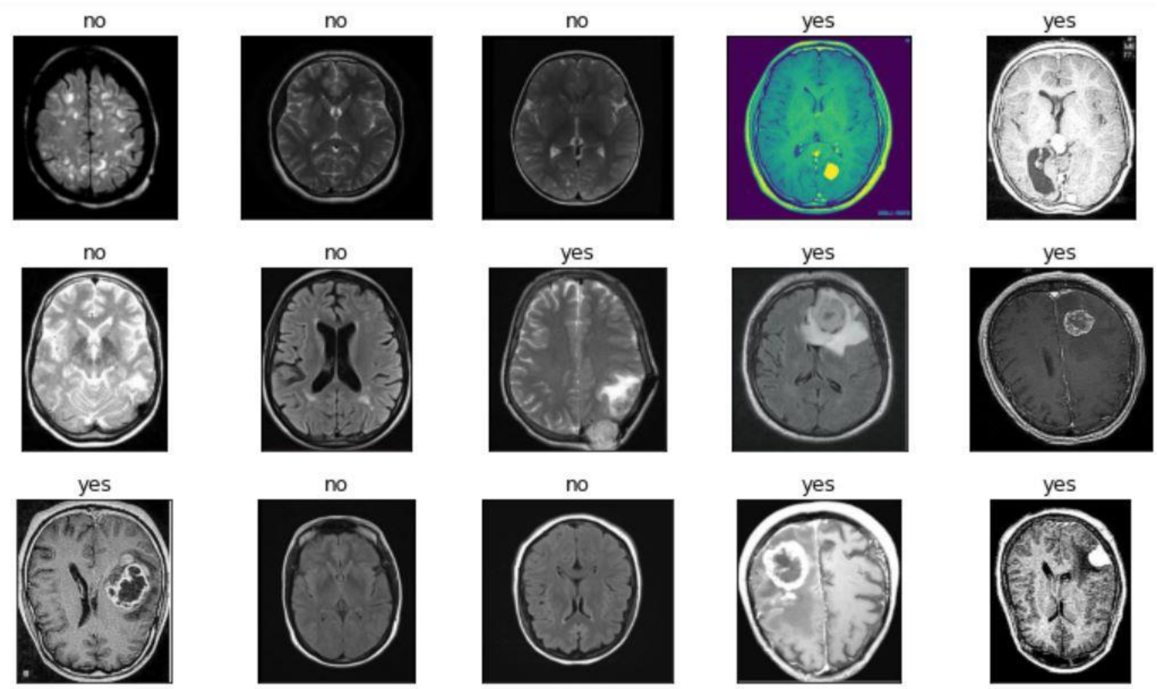


Fig.1: Existence of Tumor (Yes/No)

Unsupervised learning techniques involve the use of unlabeled data to identify patterns and clusters in brain tumor images. These techniques include clustering algorithms such as k-means clustering and hierarchical clustering. Many studies have shown that unsupervised learning techniques can be useful for identifying subtypes of brain tumors based on imaging features.
In addition to these techniques, many researchers have proposed deep learning approaches for brain tumor prediction. Deep learning models such as convolutional neural networks (CNNs) have been shown to outperform traditional machine learning algorithms in many brain tumor classification tasks.

Overall, the literature on brain tumor prediction using machine learning techniques suggests that these approaches can be effective for identifying and classifying brain tumors based on imaging features. However, further research is needed to develop more accurate and robust models that can be used in clinical settings.

a) Overview of Brain Tumors and Their Classification
Brain tumors are abnormal growths that occur in the brain tissue. They can be benign or malignant, with the latter being more aggressive and dangerous. Brain tumors are classified based on their location, cell type, and grade. The World Health Organization (WHO) has developed a classification system for brain tumors, which includes four grades, ranging from I (least malignant) to IV (most malignant).

b) Medical Imaging Techniques for Brain Tumor Detection and Diagnosis
Medical imaging techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) are commonly used for brain tumor detection and diagnosis. These techniques provide detailed images of the brain, which can be used to identify the location, size, and characteristics of the tumor.

c) Machine Learning and Deep Learning Techniques for Brain Tumor Prediction
Machine learning and deep learning techniques have been applied to predict the presence and type of brain tumors using medical imaging data. These techniques include artificial neural networks, support vector machines, random forests, and convolutional neural networks. They rely on algorithms that can learn from the data and make predictions based on patterns and features.

d) Comparison of Different Methods and Techniques Used in Brain Tumor Prediction
Studies have compared the performance of different methods and techniques used in brain tumor prediction. Some have found that deep learning techniques outperform traditional machine learning methods, while others have shown that combining multiple methods can improve prediction accuracy. Factors such as the size and complexity of the dataset, the quality of the imaging data, and the type of brain tumor being predicted can also impact the performance of these techniques.

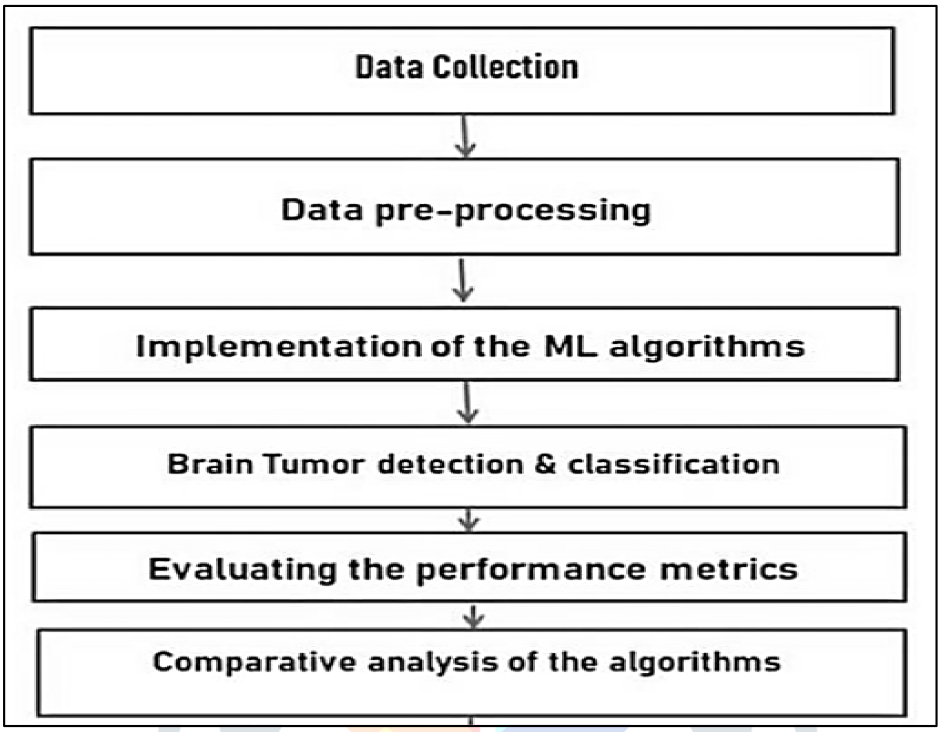
e) Identification of Research Gaps and Limitations
Despite the progress made in the field of brain tumor prediction using machine learning and deep learning techniques, there are still some limitations and research gaps that need to be addressed. These include the need for larger and more diverse datasets, the challenge of interpreting and explaining the predictions made by these techniques, and the need for more research on the clinical implementation and impact of these techniques on patient outcomes.

III. PROPOSED METHODOLOGY

The system of prediction of brain tumor using machine learning comprises of several components. The first component is the image acquisition module, which will capture MRI images of the brain and pre-process them to prepare them for analysis.

Fig. 2: Work Flow of the Proposed Model

The second component is the feature extraction module, which will extract features from the MRI images using deep learning models such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs). The third component is the classification module, which will classify the extracted features into different categories of brain tumors using supervised learning algorithms such as support vector machines (SVMs). Finally, the fourth component is the evaluation module, which will evaluate the accuracy of the system using metrics such as precision and recall.



The following methodologies of ML are implemented:

1. Logistic Regression: A type of supervised machine learning algorithm used for classification tasks that estimates the probability of an outcome based on several independent variables.
2. Decision Tree: A type of supervised machine learning algorithm used for classification and regression tasks that uses a tree-like graph to represent decisions and their possible outcomes.

3. Random Forest: A type of supervised machine learning algorithm used for classification and regression tasks that uses multiple decision trees to make predictions.

4. Naïve Bayes: A type of supervised machine learning algorithm used for classification tasks based on Bayes' theorem that assumes that the features in the data are independent of each other.

5. AdaBoost Algorithm: A type of supervised machine learning algorithm used for classification and regression tasks that combines several weak learners to form a strong learner.

6. CNN (Convolutional Neural Network): A type of artificial neural network used for image recognition and processing that is composed of multiple layers of neurons that analyze and process data from images.

7. ANN (Artificial Neural Network): A type of supervised machine learning algorithm used for classification and regression tasks that is composed of multiple layers of neurons that analyze and process data.

IV. RESULTS AND DISCUSSIONS

TP, TN, FP, FN are terms commonly used in the field of statistics and machine learning to describe the performance of a binary classification model.

• TP (True Positive): Refers to the number of cases where the model predicted the positive class correctly, i.e., the case was actually positive, and the model predicted it as positive.

• TN (True Negative): Refers to the number of cases where the model predicted the negative class correctly, i.e., the case was actually negative, and the model predicted it as negative.

• FP (False Positive): Refers to the number of cases where the model predicted the positive class incorrectly, i.e., the case was actually negative, but the model predicted it as positive.

• FN (False Negative): Refers to the number of cases where the model predicted the negative class incorrectly, i.e., the case was actually positive, but the model predicted it as negative.

These terms are important for evaluating the performance of a binary classification model, and are used to calculate metrics such as accuracy, precision, recall, and F1 score.

Results of the attributes for the calculation of performance metrics of the proposed ML algorithmsare shown in Table 1.

- **True positive (TP)** = the number of cases correctly identified as patient
- **False positive (FP)** = the number of cases incorrectly identified as patient
- **True negative (TN)** = the number of cases correctly identified as healthy
- **False negative (FN)** = the number of cases incorrectly identified as healthy

Table 1: Comparative Simulation Results of Base Algorithm and Proposed Algorithms

Models	TP	TN	FP	FN
Random Forest	336	341	16	7
Gradiant Boosting	324	237	20	19
Logistic Regression	329	249	8	14
SVM	331	250	7	12

The various metrics for evaluating performance of models are summarized in Table 2.

- Accuracy= (TP+TN)/ (TP+FP+FN+TN)
- Recall= TP/ (TP+FN)
- Precision= TP/ (TP+FP)
- F1-score= (2*Precision*Recall)/ (Precision + Recall)

Table 2: Comparison of the different ML algorithms based on accuracy, recall, precision and F1-score.

Models	Accuracy	Recall	Precision	F1-Score
Random Forest	0.9671	0.9795	0.9545	0.9668
Gradiant Boosting	0.935	0.9446	0.941	0.9427
Logistic Regression	0.9633	0.9591	0.9762	0.9675
SVM	0.968	0.9650	0.9792	0.9720

V. CONCLUSION

The use of medical imaging data, such as CT and MRI scans, can provide valuable information for predicting the presence and type of brain tumors. Further research is needed to address the limitations and challenges of using these techniques, including the need for larger and more diverse datasets, the challenge of interpreting and explaining the predictions made by these techniques, and the need for more research on the clinical implementation and impact of these techniques on patient outcomes.

VI. SCOPE OF FUTURE WORK

Integration with clinical decision-making: Future research can explore ways to integrate the predictions made by machine learning and deep learning models with clinical decision-making. This could involve developing tools that help clinicians interpret and use predictions to make treatment decisions.Improved accuracy and generalizability: Future studies can focus on improving the accuracy and generalizability of the models used for brain tumor prediction. This can involve exploring new machine learning and deep learning algorithms or developing new approaches to data preprocessing and feature extraction.Multimodal data analysis: Future research can explore ways to combine information from multiple imaging modalities, such as MRI and PET, for more accurate brain tumor prediction. This can involve developing new machine learning and deep learning models that can effectively integrate information from multiple sources.

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