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Brain Tumor Detection and Classification Using Deep Neural Network in Machine Learning Techniques

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ABSTRACT: A brain tumor is a form of cancer that has originated in the brain or has migrated there. Much further, no major reason for the creation of tumours in the brain has been found. Though brain tumours are uncommon, the death rate from malignant brain tumours is quite high due to the tumour's location in the body's most vital organ. As a basis, it is critical to accurately detect brain tumours at an early stage in order to reduce mortality. As a result, we've suggested a project to forecast and diagnose a patient's brain tumour using machine learning techniques, which would analyse brain cancers using MRI images for brain tumour diagnostic management.In this study, we applied pre-processing and also the convolution neural network technique to create a model. The study was conducted using a database retrieved from keggel.com, which is an open database that contains a set of MRI brain pictures that are then utilised in the pre-processing step. The findings show that techniques and methodologies may be trained to estimate the likelihood and kind of brain tumour in the MRI imagery produced. Image processing, pattern analysis, and computer vision techniques are used in the system, which itself is aimed at increasing the sensitivity, specificity, and efficiency of brain tumour screening.

KEYWORDS: Machine Learning, Brain Tumor, Convolution Neural Networks.

I. INTRODUCTION

The human body is composed of a large number of cells. The excessive collection of cells turns into a tumour when cell expansion becomes unchecked. CT and MRI scans are analysed to measure the tumour's location. The objective of this research is to properly identify and classify brain cancers using only a blended approach including medical image processing, pattern analysis, and computer vision for brain diagnostics enhancement, segmentation, and classification. Neurosurgeons, radiologists, and other medical practitioners can use this technology. The technology is expected to rise brain tumour screening sensitivity, specificity, and diagnostic efficiency.

The identification of brain tumours is a difficult process for analyzing tumours in respect of their categories. To categorise diverse features of brain tumours, a deep learning model based on a convolution neural network is presented. Primary and secondary tumours are two types of brain tumours that can be characterized in a variety of ways. The first divides malignancies into 3 groups: Meningioma, Glioma, and Astrocytoma. One of the most prevalent non-invasive techniques for detecting brain tumours is magnetic resonance imaging (MRI).

We mainly depend on information from the website kaggle.com. The material we've collected is in MAT format. Users may use Kaggle to discover and publish data sets, investigate and develop a model in an internet data-science environment, engage with other data scientists and machine learning engineers, and participate in data science events.

Our report concentrated on the automated segmentation and classification of brain tumours. MRI scans may usually be used to diagnose the anatomy of the brain. Because brain tumours can cause unanticipated neurological damage to the body, early diagnosis is critical for effective treatment. It's critical to predict the tumour and classify it early on so that appropriate treatments may well be performed. Different types of algorithms have already been created for the diagnosis of brain tumours, however they all have faults in terms of tumour detection and extraction.

Our vision is to develop an automated system for brain tumour enhancement, segmentation, and classification. Machine learning algorithms can potentially forecast the risk of a brain tumour given the necessary data. The outcomes of this study can help medical authorities and policymakers implement appropriate and effective brain tumour preventive actions. Neurosurgeons and healthcare experts can utilise the system.

Image processing, pattern analysis, and computer vision techniques are used in the system, which is intended to increase the sensitivity, specificity, and efficiency of brain tumour screening.

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The appropriate combination and parameterization of the aforementioned phases permits the development of auxiliary instruments that can aid in early diagnosis or treatment process monitoring.

The suggested application is motivated by the desire to assist neurosurgeons and radiologists in identifying brain cancers in a cost-effective and non-invasive way. For appropriate characterization and interpretation of biological imaging data, many processing stages are necessary. Several Clustering and Classification algorithms are being developed to improve the diagnosis process's prediction accuracy in finding anomalies.

Our research focuses on the automated identification and categorization of brain tumours. MRI or CT scans are commonly used to examine the anatomy of the brain. Our method is designed to determine whether an MRI image contains a tumour and, if so, to classify the tumour as malignant or benign.

Vector quantization, approximation, data clustering, pattern matching, optimization functions, and classification algorithms are all common uses for neural networks. The input layer, hidden layer, and output layer make up the multilayer. The recurrent network is a closed loop based feedback network. It can be inferred that the suggested system's algorithms and settings are all designed to improve the system's efficiency by producing better outcomes.

Our goal is to create a system that uses image processing and convolutional neural network techniques to improve and segment brain tumours. Using an industry-standard simulation software tool, we hope to enhance the current accuracy (diagnostic) of digital MRI images. As a result, identifying a brain tumour is important for estimating a patient's life expectancy.

[1] Data from kaggle.com should be gathered and formatted correctly.

[2] To investigate the algorithms and put them into a state of preparation.

[3] The databases are kept in the back end with suitable segmentation once they have been pre-processed.

[4] There are three types of picture segregations and two more folders named train and test datasets where the segregated datasets are placed.

[5] The algorithm is subsequently trained using test and training datasets.

[6] After the algorithm has been trained, we enter the patient's name and obtain a project analysis

[7] We also receive a process outcome analysis.

Machine learning algorithms can aid in the prediction of brain tumours when given the proper data. The results of this study can help medical authorities and lawmakers develop suitable and effective tumor-fighting measures. If given the right data, machine learning systems can help forecast the risk of a tumour.

II. LITERATURE SURVEY

[1] The experiment was conducted on a real-time dataset containing tumours of various sizes, locations, forms, and intensities. In the conventional classifier section, we used six classic classifiers built in scikit-learn: Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Multilayer Perceptron (MLP), Logistic Regression, Nave Bayes, and Random Forest.

[2] Preprocessing and segmentation were used to improve the pictures, which were obtained from an MRI image collection. Because the developed method needs fewer resources, our neural network architecture is easier to train and execute on another machine. It also includes a fully connected classification layer and a softmax layer. For the data set utilized, the total accuracy rate obtained using the proposed technique was (98,029 percent) in the testing stage and (98.29 percent) in the training stage.

[3] Preprocessing, in which pictures are normalized and bias field adjusted, and post processing, in which tiny false positives are eliminated using morphological operators, are both part of the proposed approach. The suggested technique is evaluated using the BRATS 2013 dataset, which shows that it beats state-of-the-art algorithms with similar parameters in key performance measures.

[4] The early identification of brain tumours is critical since they can be fatal if left untreated. Because it is dependent on the expertise of the person viewing the pictures, the conventional approach of manually verifying the MR image may not be particularly precise.

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We present a model that employs Convolutional Neural Networks (CNN) based on deep learning techniques to identify the main types of benign tumours, in order to improve the efficiency and accuracy of diagnosis by radiologists and neurologists.

The collection contains MRI scans of three commonly encountered labelled brain tumours: meningioma's, glioma's, and pituitary adenomas. The suggested model is trained on a large number of tagged pictures before classifying each given MRI image into one of the three categories listed above.

[5] Many neurological disorders need automated and precise structural segmentation and categorization for quantitative study. Deep learning-based picture classification and segmentation algorithms have recently piqued researchers' interest due to their ability to self-learn over large datasets. This study focuses on the usage of a Convolutional Neural Network to categorise MRI brain imaging datasets using feature maps preprocessed in the Curvelet domain.

Due to its multi-directional capabilities, curvelets give superior sparse representation and the features retrieved are more accurate than standard wavelet transforms. The segmentation methods for studying anatomical features and localization of brain tumours are next addressed, followed by the CNN's performance. When compared to the wavelet transform and standard classification algorithms such as SVM and PNN, the feature extraction in the Curvelet domain and CNN gives a higher level of accuracy.

III. SYSTEM ANALYSIS

The prediction of Brain Tumor is a source of great worry for researchers. Predicting the Brain Tumor is responsible for a certain percentage of deaths due to the high number of instances.

Our research focuses on the automated segmentation and categorization of brain tumours. MRI scans may usually be used to diagnose the anatomy of the brain. Because brain tumours can cause unanticipated neurological damage to the body, early diagnosis is critical for effective treatment. It's critical to predict the tumour and categorize it early on so that proper therapy may be arranged.Different types of algorithms have been created for the identification of brain tumours, however they all have flaws in terms of tumour detection and extraction.

A. Tools and Technologies

Python is a high-level programming language that may be used in a range of circumstances (high-level programming languages are human-understandable languages). Python was created in 1989 by Guido Van Rossam at the National Research Institute. In December 1989, Guido van Rossum of the Centrum Wiskunde en Informatica (CWI) in the Netherlands was the first to embrace Python as a substitute for the ABC dialect (which was preceded by SETL) for dealing with and communicating with the Amoeba working system. Python's inventor, Van Rossum, is still alive and well.

It is basic and straightforward to comprehend. Python has just 33 keywords compared to JAVA's 100. We can't afford to pay for open source or freeware because there isn't a licence (we can see the source code and customise it if the source isn't up to par) Python is a high-level programming language (human understandable language) Python is platform independent (I can write a programme once and run it on any machine) (WORA).

Python comes with packages that enable programmers to use more efficient algorithms. Classification, recommendation, and clustering are examples of well-known machine learning techniques. As a result, a rudimentary understanding of machine learning is necessary before proceeding.

Machine learning is a branch of computer science that deals with teaching computers to learn and develop on their own. Learning includes identifying and processing input material as well as making educated decisions depending on the information given. It is tough to evaluate all relevant inputs while making decisions. Algorithms that employ statistical science, probability, logic, mathematical optimization, reinforcement learning, and control theory to generate knowledge from particular facts and past experience are being developed to solve this challenge.The system's output data can be a floating-point number, like the rocket's velocity, or an integer, like a pigeon or a sunflower from image recognition.

Machine learning is a kind of automatic learning that involves little to no human intervention. It entails programming computers to learn from the information they are given. Machine learning's main goal is to investigate and build algorithms that can learn from previous data and make predictions based on fresh data.

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A learning algorithm's input is training data, which represents experience, and its output is any expertise, which is usually in the form of another algorithm capable of completing the task. A machine learning system's input data can be numerical, textual, auditory, visual, or multimodal.

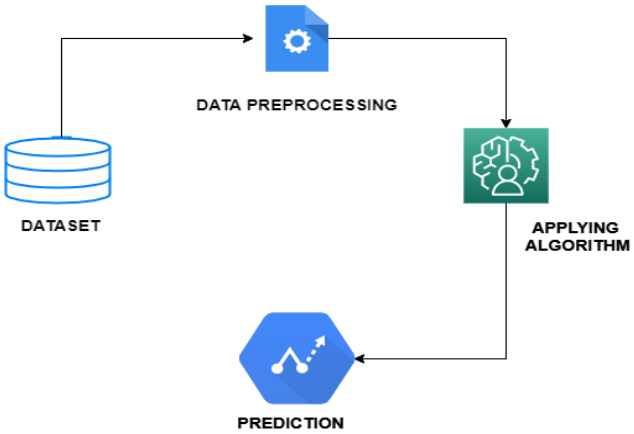
Positive and negative emotions, female and male persons, malignant diseases, risky and safe loans, and other categories are instances of attempts to choose the appropriate class designation. The aim of supervised learning is to create a general rule that maps inputs to outputs, and data includes descriptions, labels, targets, and expected results. This form of learning data is referred to as labelled data. The learnt rule is then applied to new data with unknown outputs to label it.

Unsupervised learning is used to detect abnormalities, outliers, such as fraud or faulty equipment, or to classify clients who act similarly for a sales effort. It is the polar opposite of directed instruction. There are no labels on any of the data points. When learning data only provides a few suggestions and no descriptions or labels, the coder or algorithm must figure out the underlying data's structure, find hidden patterns, or determine how to classify the data on their own. This sort of learning data is referred to as unlabeled data.

Learning data offers feedback, allowing systems to adapt to changing conditions and achieve a specified goal. The system analyses its performance and makes adjustments based on the feedback answers. Two of the most well-known examples are the chess master algorithm and self-driving vehicles.

IV. SYSTEM DESIGN

System design is the process of defining a system's architecture, components, modules, interfaces, and data to meet particular needs. It may be considered a product development application of systems theory. There is some crossover between systems analysis, systems architecture, and systems engineering. If product development as a whole "integrated the viewpoints of marketing, design, and manufacturing into a cohesive approach to product creation," design is the process of gathering marketing data and converting it into a design for a manufactured product.



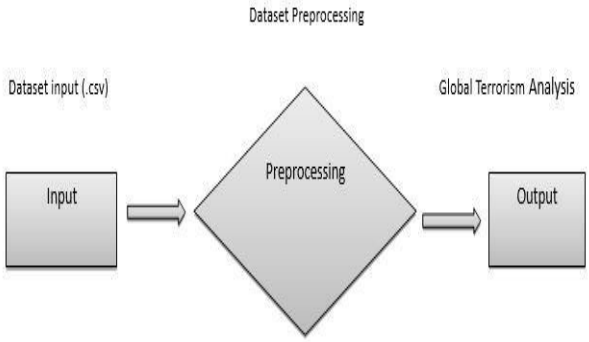


Fig. 1 System ArchitectureFig. 2 IO Design

Dataset: The Brain Tumor Detection dataset is imported from kaggle.com.

Data Preprocessing: The dataset data is preprocessed and transformed into a clean Test and Train dataset.
The Brain Tumor Detection is carried out using the Convolution Neural Network method.

Prediction: The kind of Brain Tumor is determined, as well as the life expectancy and other factors.

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Class Diagram

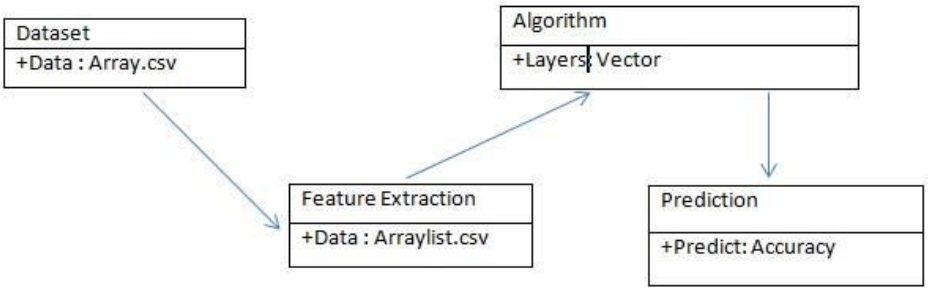
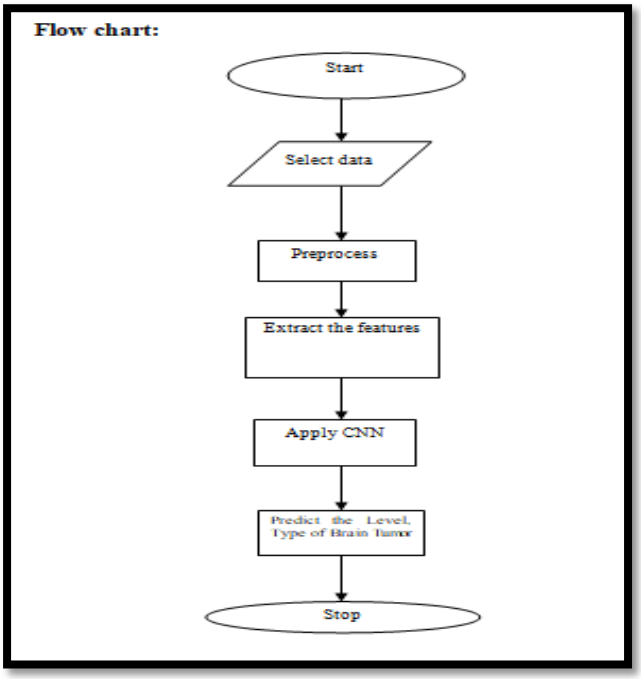


Fig. 3 Flow Design

A class diagram is a sort of static structural diagram that shows system classes, their properties, and connections between objects to illustrate the structure of a system.

Data Flow Diagram



Data flow diagrams, which are graphical depictions of data flow through information systems, are used to illustrate the process parts. They're frequently used as the first stage in generating a system overview, which may later be developed. Data processing may also be visualized using DFDs. A bubble chart is a type of DFD. It's a straightforward graphical depiction of a system's input data, different data processing processes, and the system's output data.

A. *Algorithm*

Convolution Neural Networks

A Convolutional Neural Network is a Deep Learning system that can take an image as input, assign importance (learnable weights and biases) to various aspects/objects in the image, and distinguish between them. The amount of preprocessing required by a ConvNet is significantly less than that required by other classification methods. In CNN, a convolution is a filter that is applied to different locations of the input to produce a feature map that encodes visual patterns.

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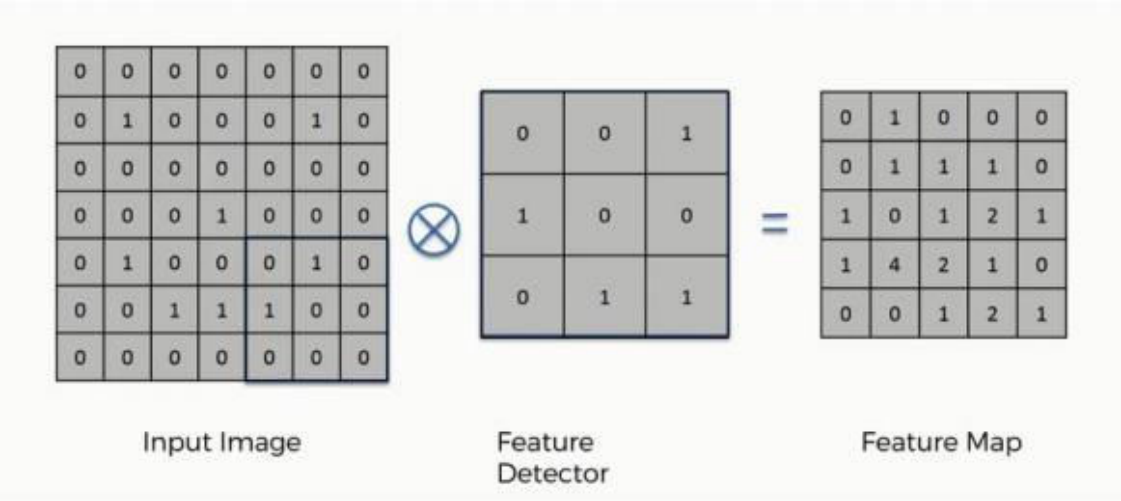

This feature map is then passed on to the following layer, which will combine and extract additional abstract features such as edges and so on. We utilize 3D convolution in our study, which applies a filter of size F @ K1i x K2i x K3i on the input picture cube, where F denotes the number of filters and I denotes the network's i-th layer.

The activation function of a node in an artificial neural network specifies the output of that node given an input or collection of inputs. A typical integrated circuit may be thought of as a digital network of activation functions that, depending on the input, can be "ON" (1) or "OFF" (0). Activation functions are an important element of a neural network's architecture.

V. IMPLEMENTATION

A. Flow Diagram

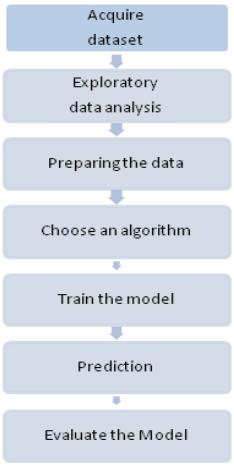

Fig. 3 Data Flow

In order to anticipate the outcome, we used machine learning algorithms while evaluating the success. Some of the models are considered in order to assess the machine learning algorithm's efficacy.

B. Gathering Data

On kaggle.com, you may find free MRI pictures of brain tumours. It provides a wealth of information on Brain Tumor MRI pictures that occurred in the United States, abroad, and across the world during this time period. Kaggle provides a customizedJupyter Notebooks environment that requires no setup. Free GPUs and a massive collection of community-published data and code are available. You'll find all the code and data you need to perform your data

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science job within Kaggle. To accomplish any analysis in no time, use over 50,000 accessible datasets and 400,000 public notebooks.

C. Preparing the Data

The process of cleaning and altering raw data prior to processing and analysis is known as data preparation. Reformatting data, making data changes, and merging data sets to better data are all part of this crucial stage before processing. For data professionals or business users, data preparation might be time consuming, but it is necessary to put data into context in order to transform it into insights and decrease bias caused by poor data quality. Standardizing data formats, enhancing source data, and/or eliminating NAN values are all common phases in the data preparation process. It's tough to include it into a machine learning model in any event.

Important tasks include:

• Outliers and unnecessary data are eliminated, among other things.
• Data with a consistent pattern.
• Values that are missing are being filled in.
• The submissions include private or sensitive information.

VI. SYSTEM TESTING

Testing is a crucial step in confirming the proposed system's quality and effectiveness in achieving its goals (satisfactorily). In order to build a transparent, adaptable, and secure system, testing is done at various phases of the system design and implementation process. The importance of software testing in the development process cannot be overstated. In certain ways, the testing process guarantees that the finished product satisfies the specifications for which it was designed. Creating test cases against which the product must be evaluated is a part of the testing process.

Levels of Testing

1) Unit Testing

The most basic form of testing is unit testing. The smallest unit of software design, the module, is tested using unit testing. A unit test is always represented as a white box. The various modules are tested using the requirements specified during the module design process. Unit testing checks the code generated throughout the coding process and tests the fundamental logic of the modules. This is usually the responsibility of the module's programmer. The coding phase is frequently referred to as "code plus unit testing" because of its tight link with coding. Unit tests may be conducted in parallel for several modules.

2) Manual and Automated Testing

A kind of software testing in which a tester executes test cases manually rather than using automated methods is known as manual testing. The goal of manual testing is to find faults, mistakes, and problems in a software product. Manual software testing is the most basic of all testing methods, and it aids in the discovery of serious problems in software applications. Before a programme can be automated, it must first be manually tested. Manual software testing takes longer and involves more effort, but it is required to determine whether or not automation is feasible. Manual testing concepts do not need any prior understanding of testing tools. One of the Software Testing Fundamentals says, "100% automation is not achievable."

3) Functional Test

Functional tests ensure that the assessed capabilities are available in a logical order, as specified by business and technical requirements, system documentation, and user manuals. Functional tests are designed and developed around requirements, key functions, and unique test cases. Furthermore, testing must include business process flows, data fields, preset procedures, and following activities in a methodical manner. More tests are identified before functional testing, and the value of current tests is assessed.

VII. CONCLUSION

After training our algorithms on a large number of MRI scans, we were able to predict the outcome of the Brain Tumor. Through image processing, the Convolution Neural Network Algorithm is considered to be accurate in detecting the tumour. The findings of this study can be used in the future to improve security against erroneous brain tumour detections.

Brain tumour has evolved into a disease with the fewest causes and diagnoses, making it extremely hazardous. Various machine learning algorithms, artificial intelligence, and data analytics have provided us with a mechanism to aid investigators, physicians, and medical officials in identifying the most likely diagnosis of Brain Tumor fast.

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We've demonstrated how techniques like the Convolution Neural Network algorithm can help us identify brain tumours eight out of ten times. This assists medical and insurance companies in detecting fraud and other inconsistencies in order to prevent profiteering and catch the actual patient.

We plan to experiment with different methodologies and approaches in the future in order to enhance the quality of t he results and, as a result, accurately diagnose the patient with more precision and accuracy.

Aside from that, we aim to build a bot to use this project to detect tumours automatically as soon as the MRI picture is generated or scanned. This will result in faster results and allow us to treat the patient more quickly. We anticipate that this project will operate at peak efficiency in order to assist the medical profession, which is currently developing a plethora of new technology.

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