VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI-590018, KARNATAKA.

A PROJECT REPORT

On

"IDENTIFICATION AND CLASSIFICATION OF BRAIN TUMOR"

Submitted in Partial Fulfillment for the Award of the Degree

of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE & ENGINEERING

Submitted By:

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(Accredited by NBA)

SAPTHAGIRI COLLEGE OF ENGINEERING

(Affiliated to Visvesvaraya Technological University, Belagavi& Approved by AICTE, New Delhi.)

ISO 9001-2015 & 14001-2015 Certified, Accredited by NAAC with 'A' Grade

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College of Engineering

Certificate

Certified that the Project Work entitled **"IDENTIFICATION AND CLASSIFICATION OF BRAIN TUMOR"** carried out by MANISHA L (1SG18CS047), bonafide student of Sapthagiri College of Engineering, in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belagavi** during the academic year 2021-2022. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the Department Library. The project report has been approved as it satisfies the academic requirements in respect of **Project Work Phase II (18CSP83)** prescribed for the said degree.

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ABSTRACT

A brain tumor is a disease caused due to the growth of abnormal cells in the brain. There are two main categories of brain tumor, they are non-cancerous (benign) brain tumor and cancerous(malignant) brain tumor. Survival rate of a tumor prone patient is difficult to predict because brain tumor is uncommon and are different types. Treatment for brain tumor depends on various factors like: the type of tumor, how abnormal the cells are and where it is in the brain etc. With the growth of Artificial Intelligence, Deep learning models are used to diagnose the brain tumor by taking the images of magnetic resonance imaging (MRI). This project detects whether the brain tumor is present or not from MRI scans. It uses the CNN classification technique which is used to classify the type of brain tumor present. If the detected tumor is non-cancerous(benign), the further classification of the type of tumor is done. The implementation of the suggested model is applied in the Python and TensorFlow environment. Algorithms and methodologies used to solve specific research problems are included in the results and along with their strengths and limitations. This examines the quantitative characteristics of brain tumors, such as shape, texture, and signal intensity, to predict high accuracy with a low error rate.

CHAPTER 1

INTRODUCTION

1.1 BRIEF INTRODUCTION

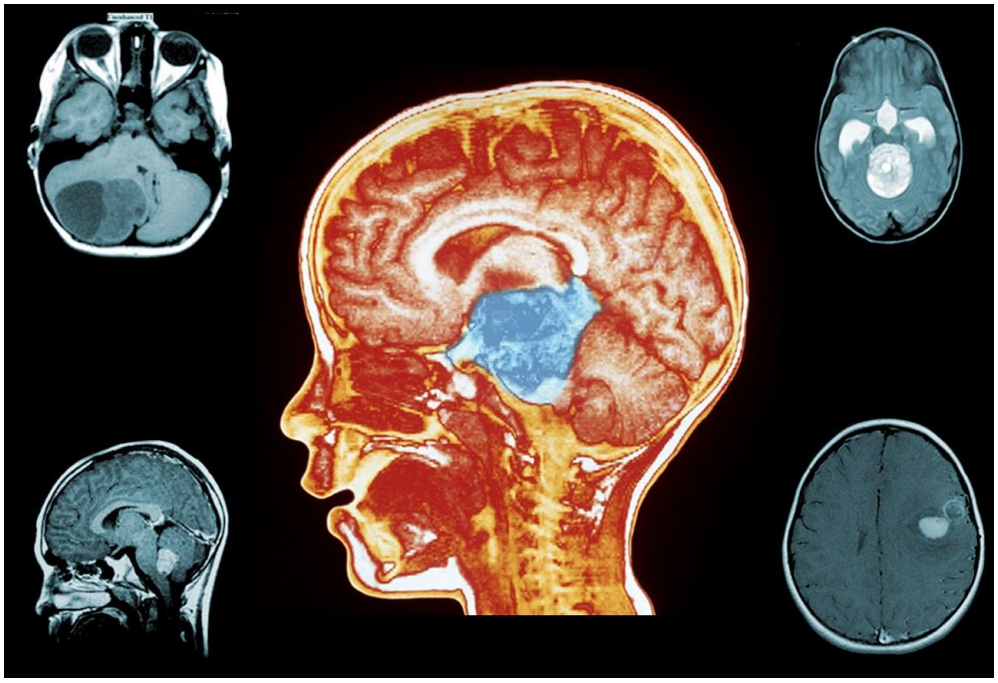

Fig 1.1 Different types of brain tumor

The brain contains billions of cells and with lots of complex functions happening every second. When the brain is damaged, there will be many things affected. Unusual development of tissue in the human brain that frustrates the best possible working of the brain is known as the brain tumor. Because of the fact that it will boost the outcome of study in a space where ill-advised bad situations must be at a low point, computer assistance is strongly advanced in therapeutic organizations. The cost of two-dimensional MRI readings is exorbitant, but excellent programming to assist people in clinical settings is of great interest these days.

A brain tumor, known as an intracranial tumor, is an abnormal mass of tissue in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells.

The two main groups of brain tumors are termed primary and metastatic**.** benign brain tumors can cause many serious issues, they are not cancerous, meaning that they grow slowly and don't typically spread to other tissues.

They also usually have more clearly defined borders, making them easier to remove surgically, and they don't usually come back after removal. On the other hand, malignant brain tumors are cancerous, grow rapidly, and can spread to other parts of your brain or central nervous system, which can cause life-threatening complications.

Brain tumors are thought to arise when certain genes on the chromosomes of a cell are damaged and no longer function properly. These genes normally regulate the rate at which the cell divides (if it divides at all) and repair genes that fix defects of other genes, as well as genes that should cause the cell to self-destruct if the damage is beyond repair. In some cases, an individual may be born with partial defects in one or more of these genes. Environmental factors may then lead to further damage. In other cases, the environmental injury to the genes may be the only cause. It is not known why some people in an "environment" develop brain tumors, while others do not.

Once a cell is dividing rapidly and internal mechanisms to check its growth are damaged, the cell can eventually grow into a tumor. Another line of defense may be the body's immune system, which optimally would detect the abnormal cell and kill it. Tumors may produce substances that block the immune system from recognizing the abnormal tumor cells and eventually overpower all internal and external deterrents to its growth.

Human onlookers describe the tumor's highlights of traditional techniques. A mechanised symptomatic structure with certain anatomical highlights has been implemented to increase the accuracy of the present framework. To improve accuracy, a symptomatic system has been developed. Manual segmentation takes sensible time and precision will be less and it prompts bury and intra rater blunders. Programmed segmentation is required because of this reason.

Programmed segmentation gives the data about the encompassing tissues around the tumor. This is because of the intensity variation happening among the same groupings. Segmentation in MRI utilized in treatment checking and gaining up prominence with progress in picture guided surgical methodologies.

Laying out of tumor contours is an essential advance. This technique depends on CNN and learn highlights that are explicit to gliomas detection and segmentation.

1.1.1 MACHINE LEARNING

Machine learning (ML) is the study of computer algorithms that improve automatically through experience and by the use of data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics.

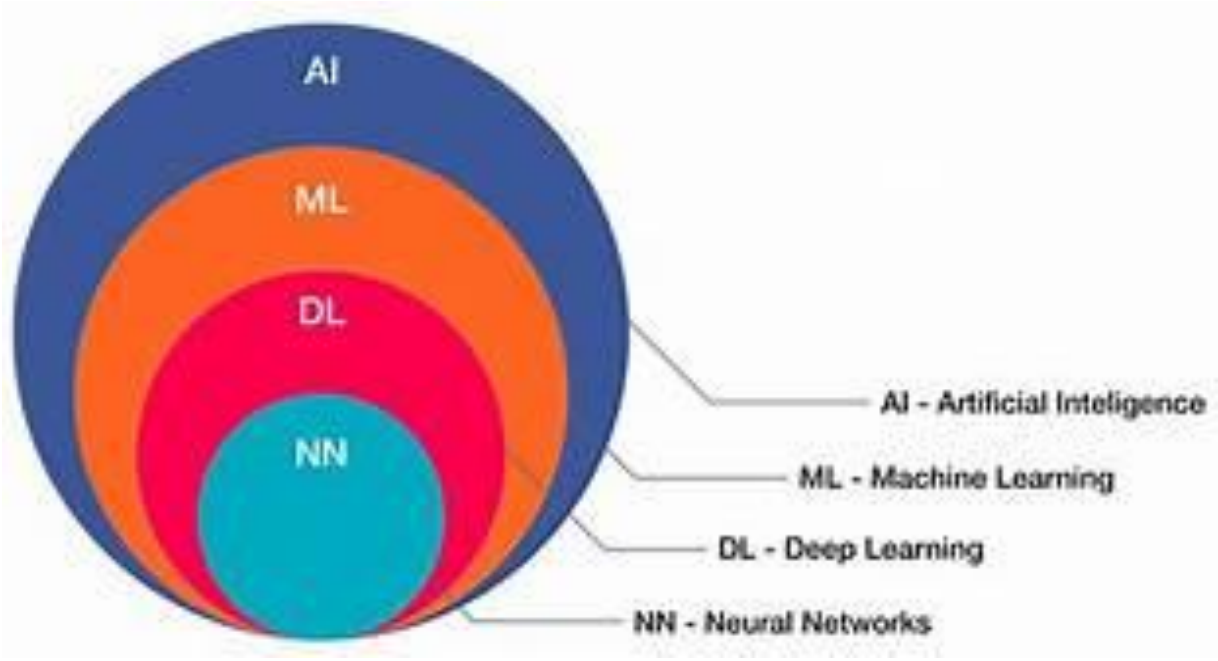

Fig 1.2 Venn diagram to represent fields of artificial intelligence

1.1.2 MACHINE LEARNING ALGORITHMS

- **SUPERVISED LEARNING**

A support-vector machine is a supervised learning model that divides the data into regions separated by a linear boundary. Here, the linear boundary divides the black circles from the white. Supervised learning algorithms build a mathematical model of a set of data that contains both the inputs and the desired outputs. The data is known as training data and consists of a set of training examples.

In the mathematical model, each training example is represented by an array or vector, sometimes called a feature vector, and the training data is represented by a matrix. Through iterative optimization of an objective function, supervised learning algorithms learn a function that can be used to predict the output associated with new inputs. An optimal function will allow the algorithm to correctly determine the output for inputs that were not a part of the training data. An algorithm that improves the accuracy of its outputs or predictions over time is said to have learned to perform that task. Types of supervised learning algorithms include active learning, classification and regression.

Classification algorithms are used when the outputs are restricted to a limited set of values, and regression algorithms are used when the outputs may have any numerical value within a range. As an example, for a classification algorithm that filters emails, the input would be an incoming email, and the output would be the name of the folder in which to file the email. Similarity learning is an area of supervised machine learning closely related to regression and classification, but the goal is to learn from examples using a similarity function that measures how similar or related two objects are. It has applications in ranking, recommendation systems, visual identity tracking, face verification, and speaker verification.

This algorithm consists of a target / outcome variable (or dependent variable) which is to be predicted from a given set of predictors (independent variables). Using these set of variables, a function is generated that map inputs to desired outputs. The training process continues until the model achieves a desired level of accuracy on the training data.

- **UN-SUPERVISED LEARNING**

Unsupervised learning refers to the use of artificial intelligence (AI) algorithms to identify patterns in data sets containing data points that are neither classified nor labeled. The algorithms are thus allowed to classify, label and/or group the data points contained within the data sets without having any external guidance in performing that task. In other words, unsupervised learning allows the system to identify patterns within data sets on its own.

In unsupervised learning, an AI system will group unsorted information according to similarities and differences even though there are no categories provided. Unsupervised learning algorithms can perform more complex processing tasks than supervised learning systems. Additionally, subjecting a system to unsupervised learning is one way of testing AI.

However, unsupervised learning can be more unpredictable than a supervised learning model. While an unsupervised learning AI system might, for example, figure out on its own how to sort cats from dogs, it might also add unforeseen and undesired categories to deal with unusual breeds, creating clutter instead of order. AI systems capable of unsupervised learning are often associated with generative learning models, although they may also use a retrieval-based approach. Chatbots, self-driving cars, facial recognition programs, expert systems and robots are among the systems that may use either supervised or unsupervised learning approaches, or both.

This algorithm is used for clustering population in different groups, which is widely used for segmenting customers in different groups for specific intervention. Examples of Unsupervised Learning: Apriori algorithm, K-means. Cluster analysis is the assignment of a set of observations into subsets (called clusters) so that observations within the same cluster are similar according to one or more predesignated criteria, while observations drawn from different clusters are dissimilar. Different clustering techniques make different assumptions on the structure of the data, often defined by some similarity metric and evaluated, for example, by internal compactness, or the similarity between members of the same cluster, and separation, the difference between clusters. Other methods are based on estimated density and graph connectivity.

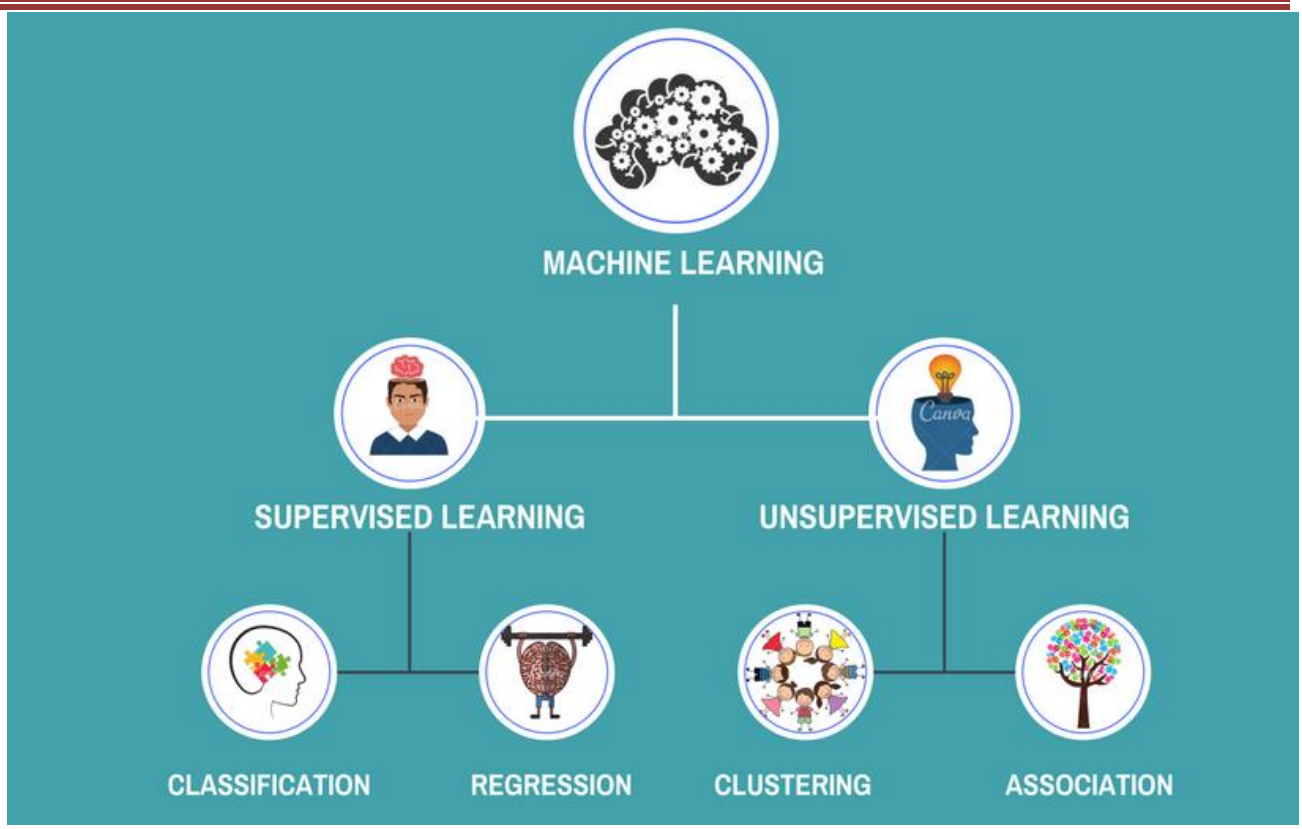

Fig 1.3 supervised and un-supervised learning

Table 1.1 Difference between supervised and un-supervised learning

Supervised Learning	Unsupervised Learning
Supervised learning algorithms are trained using labeled data.	Unsupervised learning algorithms are trained using unlabeled data.
Supervised learning model takes direct feedback to check if it is predicting correct output or not.	Unsupervised learning model does not take any feedback.
Supervised learning model predicts the output.	Unsupervised learning model finds the hidden patterns in data.
In supervised learning, input data is provided to the model along with the output.	In unsupervised learning, only input data is provided to the model.
The goal of supervised learning is to train the model so that it can predict the output when it is given new data.	The goal of unsupervised learning is to find the hidden patterns and useful insights from the unknown dataset.
Supervised learning needs supervision to train the model.	Unsupervised learning does not need any supervision to train the model.

Supervised learning can be categorized in Classification and Regression problems.	Unsupervised Learning can be classified in Clustering and Associations problems.
Supervised learning can be used for those cases where the input as well as corresponding outputs are known.	Unsupervised learning can be used for those cases where only input data is known and no corresponding output data.
Supervised learning model produces an accurate result.	Unsupervised learning model may give less accurate result as compared to supervised learning.
Supervised learning is not close to true Artificial intelligence as in this, first train the model for each data, and then only it can predict the correct output.	Unsupervised learning is more close to the true Artificial Intelligence as it learns similarly as a child learns daily routine things by his experiences.
It includes various algorithms such as Linear Regression, Logistic Regression, Support Vector Machine, Multi-class Classification, Decision tree, Bayesian Logic, etc.	It includes various algorithms such as Clustering, KNN, and Apriori algorithm.

- **DECISION TREE**

Decision tree is the most powerful and popular tool for classification and prediction. A Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.

Decision tree learning uses a decision tree as a predictive model to go from observations about an item to conclusions about the item's target value.

It is one of the predictive modeling approaches used in statistics, data mining, and machine learning. A tree can be “learned” by splitting the source set into subsets based on an attribute value test. This process is repeated on each derived subset in a recursive manner called recursive partitioning. The recursion is completed when the subset at a node all has the same value of the target variable, or when splitting no longer adds value to the predictions. The construction of decision tree classifier does not require any domain knowledge or parameter setting, and therefore is appropriate for exploratory knowledge discovery.

Decision trees can handle high dimensional data. In general decision tree classifier has good accuracy. Decision tree induction is a typical inductive approach to learn knowledge on classification.

Tree models where the target variable can take a discrete set of values are called classification trees; in these tree structures, leaves represent class labels and branches represent conjunctions of features that lead to those class labels.

Decision trees where target variable can take continuous values (typically real numbers) are called regression trees. In decision analysis, a decision tree can be used to visually and explicitly represent decisions and decision making. In data mining, a decision tree describes data, but the resulting classification tree can be an input for decision making.

- **SUPPORT VECTOR MACHINES**

Support-vector machines (SVMs), also known as support-vector networks, are a set of related supervised learning methods used for classification and regression. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that predicts whether a new example falls into one category or the other. An SVM training algorithm is a non-probabilistic, binary, linear classifier, although methods such as Platt scaling exist to use SVM in a probabilistic classification setting.

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high dimensional feature spaces.

- **REGRESSION ANALYSIS**

Regression analysis encompasses a large variety of statistical methods to estimate the relationship between input variables and their associated features. Its most common form is linear regression, where a single line is drawn to best fit the given data according to a mathematical criterion such as ordinary least squares. The latter is often extended by regularization (mathematics) methods to mitigate overfitting and bias, as in ridge regression. When dealing with non-linear problems, go-to models include polynomial regression logistic regression or even kernel regression, which introduces non-linearity by taking advantage of the kernel trick to implicitly map input variables to higher-dimensional space.

- **BAYESIAN NETWORK**

A Bayesian network, belief network, or directed acyclic graphical model is a probabilistic graphical model that represents a set of random variables and their conditional independence with a directed acyclic graph (DAG). For example, a Bayesian network could represent the probabilistic

relationships between diseases and symptoms. Given symptoms, the network can be used to compute the probabilities of the presence of various diseases. Efficient algorithms exist that perform inference and learning. Bayesian networks that model sequences of variables, like speech signals or protein sequences, are called dynamic Bayesian networks. Generalizations of Bayesian networks that can represent and solve decision problems under uncertainty are called influence diagram.

1.1.3 ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANNs), or connectionist systems, are computing systems vaguely inspired by the biological neural networks that constitute animal brains. Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules. An ANN is a model based on a collection of connected units or nodes called "artificial neurons", which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit information, a "signal", from one artificial neuron to another.

An artificial neuron that receives a signal can process it and then signal additional artificial neurons connected to it. In common ANN implementations, the signal at a connection between artificial neurons is a real number, and the output of each artificial neuron is computed by some non-linear function of the sum of its inputs.

Artificial neurons may have a threshold such that the signal is only sent if the aggregate signal crosses that threshold. Typically, artificial neurons are aggregated into layers. Different layers may perform different kinds of transformations on their inputs. Signals travel from the first layer (the input layer) to the last layer (the output layer), possibly after traversing the layers multiple times.

The original goal of the ANN approach was to solve problems in the same way that a human brain would. However, over time, attention moved to performing specific tasks, leading to deviations from biology. Artificial neural networks have been used on a variety of tasks, including computer vision, speech recognition, machine translation, social network filtering, playing board and video games and medical diagnosis.

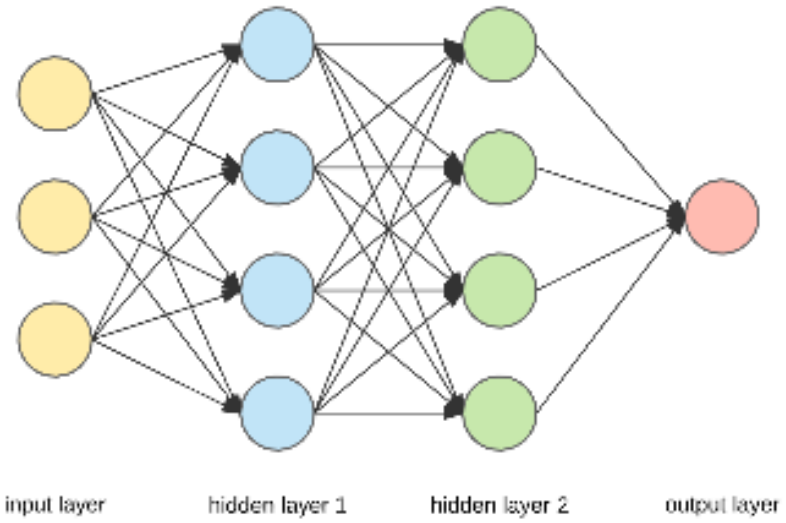

Fig 1.4 Artificial neural network

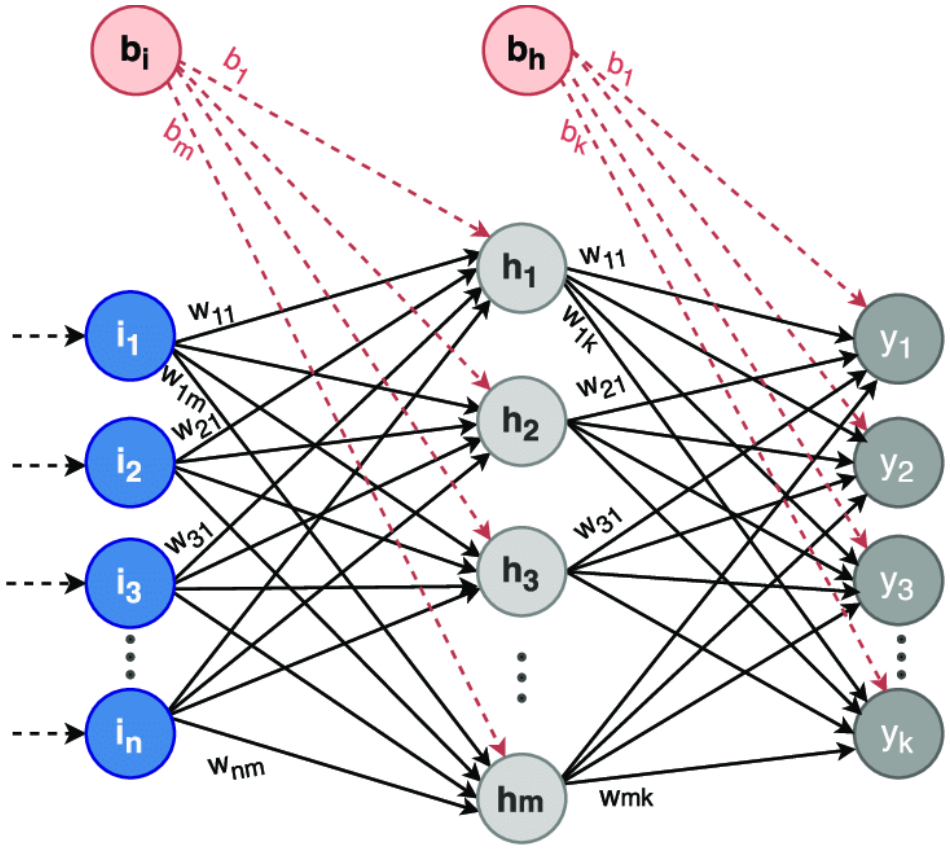

Fig 1.5 ANN Architecture

1.1.4 BRAIN TUMOR

A brain tumor is an ailment caused due to the growth of anomalous cells in the brain. There are two main essential classes of brain tumor, they are non-cancerous (benign) brain tumor and cancerous(malignant) brain tumor. Survival rate of a tumor prone patient is difficult to predict because brain tumor is rare and are of different types. Treatment for brain tumor depends on various factors like: the type of tumor, how abnormal the cells are and where it is in the brain etc.

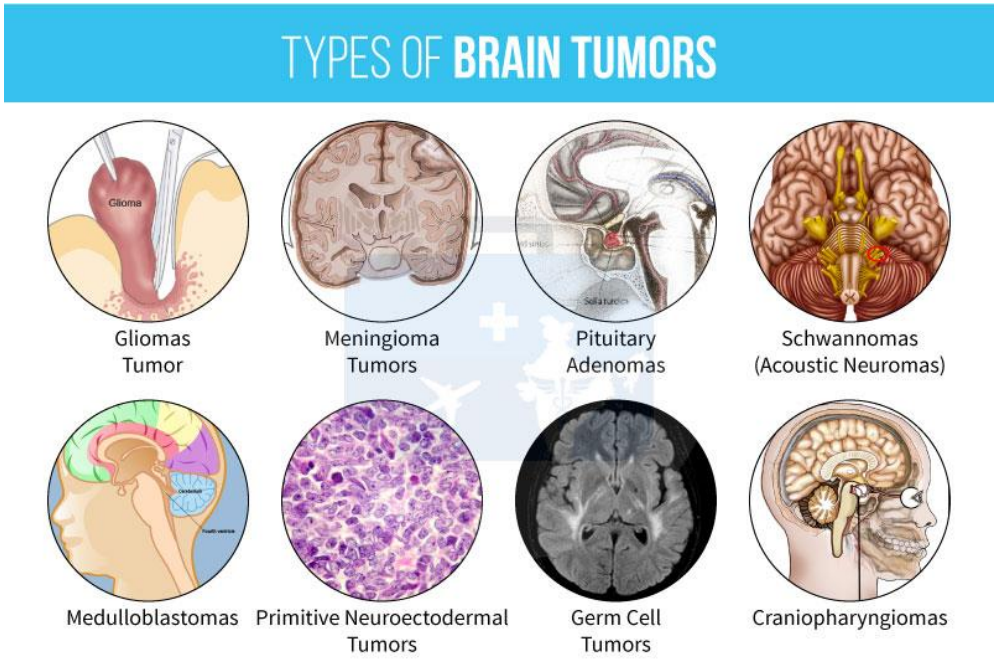

Fig 1.6 Types of brain tumors

Malignant tumors are considered cancerous and should be treated with proper measures. Types of malignant tumor are:

- **Carcinoma**: These tumors form from epithelial cells, which are present in the skin and the tissue that covers or lines the body's organs. Carcinomas can occur in the stomach, prostate, pancreas, lung, liver, colon, or breast. They are a common type of malignant tumor.
- **Sarcoma**: Sarcomas start in connective tissue, such as cartilage, bones, fat, and nerves. They originate in the cells outside the bone marrow. Most sarcomas are malignant.
- **Germ cell tumor**: These tumors develop in the cells that produce sperm and eggs. They usually occur in the ovaries or testicles but may also appear in the brain, abdomen, or chest.

- **Blastoma**: These tumors form from embryonic tissue or developing cells. Blastomas are much more common in children than in adults. They can lead to tumors in the brain, eye, or nervous system.
- **Meningiomas**: These are among the most common types of brain tumors and sometimes require excision or treatment if they are causing symptoms.

Benign tumors are considered non-cancerous. Detection in early stages can result in complete cure. Common types of benign brain tumors include:

- **Acoustic neuroma** (also called a vestibular schwannoma) grows on the nerves near your inner ear. It may affect your balance or hearing abilities.
- **Meningioma** is a type of brain tumor that is usually benign and tends to grow slowly.
- **Pituitary adenoma** is a tumor that occurs on the pituitary gland, located at the bottom of the skull. Pituitary tumors can sometimes affect your hormone production, which may cause you to feel sick or not like yourself.

Classifications discussed in this project are:

- Glioma tumor: Glioma is a type of tumor that occurs in the brain and spinal cord. Gliomas begin in the gluey supportive cells (glial cells) that surround nerve cells and help them function.
- Meningioma tumor: A meningioma is a tumor that arises from the meninges — the membranes that surround the brain and spinal cord. Although not technically a brain tumor, it is included in this category because it may compress or squeeze the adjacent brain, nerves and vessels. Meningioma is the most common type of tumor that forms in the head.

- Oligodendroglioma tumor: Oligodendroglioma is a brain tumor arising from oligodendrocytes, the name for cells that normally wrap around and provide support to nerve fibers in the brain. These tumors can develop anywhere in the brain, but are more commonly found in the frontal and temporal lobes.
- Glioblastoma Multiforme tumor: Glioblastoma (GBM), also referred to as a grade IV astrocytoma, is a fast-growing and aggressive brain tumor. It invades the nearby brain tissue, but generally does not spread to distant organs. GBMs can arise in the brain de novo or evolve from lower-grade astrocytoma.

- Pituitary tumor: Pituitary tumors are abnormal growths that develop in your pituitary gland. Some pituitary tumors result in too much of the hormones that regulate important functions of your body. Some pituitary tumors can cause your pituitary gland to produce lower levels of hormones.

1.2 Problem Statement

The aim of this project is to detect and classify the type of brain tumor.

1.3 Objectives

The main objective behind this project is to detect the brain tumor present or not and further it detects whether the tumor is cancerous(malignant) or non-cancerous(benign).If the tumor is non-cancerous this project further classifies it into different types such as Glioma, Meningioma and Pituitary tumor.

1.4 Organisation of the project

- Chapter 1: This chapter provides brief introduction about the project.
- Chapter 2: Provides information about the literature survey of the existing system.
- Chapter 3: Provides information about the system requirements needed to run the project.
- Chapter 4: Provides information about the system and methodology of the project.
- Chapter 5: Provides information about the implementation of each module in a precise manner.
- Chapter 6: Provides information about the experiments conducted and the results obtained.
- Chapter 7: Provides information about testing and results.
- Chapter 8: Provides information conclusion and future enhancement.

CHAPTER 7

CONCLUSION AND FUTURE WORKS

CONCLUSION

Brain tumors are relatively rare compared, that is, 1.4% of new cases per year, in developed countries. Deaths from brain tumors have increased in the last few decades. Therefore, the scope of this project is expanded. Brain tumors, especially those that are harmful, are considered to be incurable and deadly. The need for early detection stems from the fact that brain tumors may have invisible and frightening symptoms at first. To identify the type of tumor in the brain, a dangerous medical procedure was performed and a biopsy was performed. This project proposes a way to detect and diagnose the type of brain tumor that is based on MRI (Magnetic Resonance Imaging) of a patient-fed scan of the system. It also provides an accurate diagnosis of existing brain tumors based on CNN classification algorithm. Biopsy can be greatly avoided due to the precise discharge of the system. This is considered to be the least expensive way to solve a brain tumor problem. Previous systems have used various algorithms and methods to prove the existence of a brain tumor by machine learning. This system provides a clear picture of the precise tumor present in the patient by considering various factors such as location, size etc. This method proves to be an accurate and effective method of diagnosing a brain tumor problem.

FUTURE SCOPE

Build an app-based user interface in hospitals which allows doctors to easily determine the impact of tumor and suggest treatment accordingly Since performance and complexity of ConvNets depend on the input data representation we can try to predict the location as well as stage of the tumor from Volume based 3D images.

By creating three dimensional (3D) anatomical models from individual patients, training, planning and computer guidance during surgery is improved. Using VolumeNet with LOPO (LeaveOne-Patient-Out) scheme has proved to give a high training as well as validation accuracy(>95%).

In LOPO test scheme, in each iteration, one patient is used for testing and remaining patients are used for training the ConvNets, this iterates for each patient.

Although LOPO test scheme is computationally expensive, using this we can have more training data which is required for ConvNets training. LOPO testing is robust and most applicable to our application, where we get test result for each individual patient.

So, if classifier misclassifies a patient, then we can further investigate it separately. Improve testing accuracy and computation time by using classifier boosting techniques like using more number images with more data augmentation, fine-tuning hyper parameters, training for a longer time i.e. using more epochs, adding more appropriate layers etc.. Classifier boosting is done by building a model from the training data then creating a second model that attempts to correct the errors from the first model for faster prognosis. Such techniques can be used to raise the accuracy even higher and reach a level that will allow this tool to be a significant asset to any medical facility dealing with brain tumors. For more complex datasets, we can use U-Net architecture rather than CNN where the max pooling layers are just replaced by up sampling ones. Ultimately we would like to use very large and deep convolutional nets on video sequences where the temporal structure provides very helpful information that is missing or far less obvious in static images. Unsupervised transfer learning may attract more and more attention in the future

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