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Project Submission Sheet – 2021/2022

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Using Deep Learning Methods For Detection of Brain Tumour

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***Abstract*—Deep Learning possess a large subsection of Machine Learning which examines algorithms based on Data structures and activity of brain known as Artificial Neural Network (ANN).The learning is sub divided into three categories called as supervised, unsupervised and semi- supervised.These Neural Networks are basically algorithms which are developed by the structure of human brain.Now-a-days Health care sectors are producing large amount of data.So by analysis and amplification of the data in a definite way will help in upgrading patient's results in various ways.As the accuracy and results produced by using Deep Learning methodology are satisfactory it is a perfect technique for building a model which will help in finding cancer and detection of Brain Tumour..The combination of using references of already produced images of Brain by doing Magnetic Resonance Scans (MRI) and implementation of specific Deep Learning models will assist in successful detection of Brain tumour.The research was performed by using two models CNN and VGG16.Where it was concluded that CNN was best suited model after successfully studying three evaluation techniques such as Accuracy and validation loss, F1 score and Confusion matrix.**

***Index Terms*—Convolutional Neural Network, VGG16, KDD**

I. Introduction

The successful evolution in computing has lead to major development in multiple sectors.These sectors are now integrated by using Data in such a way that it gives explicit results in very short time.Each and every sector has its own history which is stored and maintained in the form of Data which helps in referring and improve the current method of implementation which might increase the pace, accuracy and results of a particular tasks or job.To be more specific, by using certain algorithms of Machine Learning and Deep learning it has made real world more direct and precise by replacing old methods and techniques.Some of the important research work are explained as follows, In Speech recognition it has the ability to translate a speech into a text file popularly known as voice search and voice dialling.Also there are car's which are automatic and are specifically made to avoid dangerous accidents.In online Marketing commonly known as E-commerce sector has received major boost due Artificial Intelligence by using Deep Learning and Machine Learning techniques it is possible for users to search for specific product plus it is also displayed on users homepage and social media platforms based on their current or past searches and interests. Medical and Healthcare centre sector have also gained the importance of use of Machine Learning to get familiar with the treatment of new techniques as a update to the old techniques which are likely to be time consuming. One such method of Machine Learning and Deep Learning was used during the period COVID-19. The development of vaccine was the primary aim to prevent one from getting acquainted from this disease.The algorithms were helpful in predicting the amount of disease spread in particular location and also the age factor, immunity of patients and several other factors were studied by using Machine learning techniques.

In medical world now a days there has been large number of small scale projects present which are at the verge of presenting their commercial full scaled projects in coming years.In medical sectors there is large amount of data available already .The Data might contain the number of patients having the same or the other diseases, history of the disease, Symptoms, etc Thus in order to make use of the past data and integrating it by using definite algorithm and using computational way it is possible to predict the future trends, the possibility of spread of the disease, cures and prevention of the disease etc.Before the implementation of models it is important of have mandatory pre-processing of the available data. Thus To make the entry of data with a high pace and seamlessly the use of Optical Recognition Technology can be used.In OCR automatic extraction of data from printed text from a document and it is further converted into a machine-readable form.The image classification is the most reliable way to study the previous raw image data and then compare it with the currently processed and applied models of image data for prediction and analysis of the data.One such method can be used is Detection of Brain tumour using Deep Learning Technique.Brain is one of the most important and governing part of body. These days,Brain tumour is become life threatening problem which is why it is necessary to be pin pointed as early as possible. Brain tumour is basically a freakish lump of flesh which

is uncontrolled growth due to multiplication of cells.Brain tumour is differentiated into two types called as primary and secondary brain tumour. Primary brain tumour originates from the brain itself whereas secondary brain tumour stems out in different body part and then migrates into the brain through the flow of blood.

To take proper actions and simplify the medical data which includes high graphical images it requires integrated algorithms which is satisfied by Convolutional Neural Network. Deep learning technique offers smooth operation even with the larger data set of images which are lined up to be scanned.By using CNN it is possible to overtake traditional approach of diagnosing and predicting the explanatory features from the images.It is observed that by using CNN Neurological conditions like strokes and brain tumour were able to detect than 150 times than human urologists.The study of brain tumour are not limited only for the sake of detecting tumours but also for finding good and healthy cells.

The primary aim of this research work is to study about the brain tumours with the help of Convolutional Neural Network(CNN). This research will not only help to detect brain tumour faster but also to decrease the analysis time of human trainee. As the traditional human approach for detecting brain tumour is bound to make error in some analysis it is very feasible to use these Deep Learning models which are fast and accurate.

II. Literature Review

A study by Mehmet Sevi and Aydin used Deep Learning methods for the detection of Covid-19. This technique was introduced as a substitute to the Polymerase Chain reaction (PCR) test. The primary aim of this study is to detect the disease of a individual from the X-ray images taken for the suspected Covid-19.The dataset comprises of X-rays images of patients having COVID-19, pneumonia and also healthy patients.Multi-class classification was done on the three groups using Deep Learning models.The research concluded by suggesting VGG19 as the successful model having 95% accuracy rate and the three groups were successfully classified by VGG19 model.[1]

Another study by Zennat et al. is based on Disease classification using Deep Convolutional Neural Network. This research work is focuses to find the degree of accuracy in medical field by using deep learning to the available dataset. The study was implemented by first extracting spectogram features of the marginalize lung which were used as an input to the 2D Convolutional Neural Network.The Data is futher preprocessed by removing unwanted noise and values. Advanced Root Mean Square Normalization and data augmentation techniques such as Time Stretching , Pitch Shifting and Dynamic Range Compression were applied successfully and high accuracy of 97% was obtained.Hence the proposed model is well suited for diagnosis of lung diseases.[2]

Geographical access plays an vital role in medical resources being set up at a particular location.A patient prefers to have medical organisation at a easy access route.The main goal of this research work is to define a Deep neural network approach to model the patient's preference for travelling a distance for accessing care.The Data used in this research is an insurance data of Taiwan.For implementation was done by using CNN which is tested against all the other Machine Learning models such as Random forest, SVM, Multi-layer perception.The study concluded by showing results in favour of CNN which completely beats Machine Learning models.The CNN-based framework achieved shows an accuracy of 96%.It handled all the complex combinations of features and imbalanced Datasets.[3]

In the research proposed by Guoming et al., CNN classifier base on image bit-plane is used to increase the accuracy by applying it to the image classification of breast cancer. In this study each of the texture image is differentiated into eight bit-plane images.By the observation of bit-plane slicing it is concluded that the classification accuracy increases and becomes better by each step when it is been compared with original image.From this research the main is to improve the recognition rate and classification performance which is done by bit slicing method.[4]

The research work based on Detection of tuberculosis in Radiographs using Deep Learning-based Ensemble Methods the main aim was to present the execution of ensemble methods using stacked generalization. The Deep Learning techniques such as VGGNet, DenseNEt and EfficentNet models were used to test the pre-trained models. The biggest concern of data standardization was addressed by using DICOM which is then converted into readable form.The implementation of filtering is done for removing unwanted noise and get clean segmented regions.[5]

Mehedi et al., conducted research on detecting colon cancer using deep learning methods such as multi-channel CNN and digital image processing which will help to detect cancer at early stage, with less time, effort and cost. The aim of their research is to classify 5 kind of cancer tissues depending upon various factors like size, area, etc. by using images using supervised learning. They used LC25000 dataset and they got 4 properties using image transformation classification where there were 2 types and then combined them into one which contained both features. They acquired higher f-score i.e., 96.33% of accuracy for cancer identification. Their study had few drawbacks which can be improved. According to them, their method showed better performance compared to similar study. They concluded their research by future scope which will help to identify new traits which will help to improve performance.[6]

Swapna et al., done research on diabetes and also used input heart rate variability which was collected from 20 people with normal and diabetic which can be used to detect non-invasive diabetes detection using deep learning algorithms. They combined long short-term memory and CNN to extract HRV data and are classified using 5-fold cross-validation support vector machine. GPU based TensorFlow was used to conduct these experiments. They had earlier conducted the same research but without using SVM. SVM using RBF kernel yield better

performance. They got an accuracy of 95.7% which was high and also better than their earlier research. They conclude by future scope where using large sixed dataset can be used which can yield better accuracy and better performance.[7]

Liaqat et al, conducted research for automated detection of heart disease using deep learning methods. they proposed hybrid model using x2 statistical method by using deep neural network which is compared to ANN and DNN models and the performance was evaluated using 6 various metrics like accuracy, AUC, etc. they conducted 5 experiments using different models and comparing them. They also compared the results with the machine learning models. The problem of overfitting and underfitting was avoided to get better accuracy using both train and test data. Irrelevant traits caused overfitting of train data which was eliminated using this x2 statistical model. Their proposed model yield accuracy of 93.33% which was also compared to earlier research and according to them their model performed better which will help to improve the diagnosis of heart disease. They research had drawback i.e., though it gave better detection rate for heart disease but it could not detect the complexity of time which can be done in future work. Another limitation in their research was, grid search method was used to search the optimal width of ANN and DNN layer which in future can be done using fast methods like genetic.[8]

Knowing the stage of the tumor from its growth and how it has spread is critical once it has been discovered. As a result, they will grade the brain tumor using deep learning algorithms. Similarly, it is feasible to do so by taking MRI pictures and then subjecting them to the appropriate Deep learning algorithms, which will aid in comparing and understanding the stage of the tumor, which will lead to grading. They applied a convolutional neural network and a simple neural network to achieve this. As a result, when the sensitivity and specificity of the CNN model were evaluated, the CNN model showed an 18% improvement in grading. In addition, the Convolution neural network proved helpful in obtaining some additional properties.[9]

B.Sudha et al., her colleagues proposed research in which they used a few neural network models to help categorize tumor grades. Initially, feature extraction was performed so that each image could be segmented into a specific category based on its content and features, making classification easier later on. They performed image segmentation using GLCM feature extraction and GLRM feature extraction, and later with GLRM, feature selection was done using the fuzzy entropy measure. Similarly, three classifier models, such as FFNN, MLPN, and BPNN, were used to classify brain tumor grades. According to them, BPNN models were the most appropriate, with an accuracy of 96.7 percent. Sensitivity, specificity, and accuracy are the major goals to achieve, and feature optimization was taken into account to get the best accuracy. Finally, for more advanced techniques, an ANN model would be more powerful and useful in achieving good results.[10]

Breast cancer is a serious disease that can be found very easily amongst women. Thus, it becomes very important to have a fast treatment. In this paper, With the help of a machine learning model. KNN, Random Forest, and Naïve byes were used in this paper. Initially, the Mammogram which is an x-ray image to find cancer in the breast is taken later it is followed by doing feature extraction. when both the testing and training data were given for image segmentation. Thus, when the image was extracted and imported to the exact category. later, classification techniques are used thus, these three machine learning models were implemented where their aim was to show whether the cancer is Benign or Malign. After, completion of the process. According to them, Random Forest shows the best performance of about 94.74% of accuracy, 92% and 93% of precision and Recall. While evaluating looking out for this in terms of models is very important and at the same time is also shows how efficient Random Forest is in detecting and classifying the tumor in the breast.[11]

Khusbhoo et. al, her team conduct research on cancer diagnosis using deep learning, which not only aids in the diagnosis of the disease but also in its classification, providing a historical perspective on cancer classification methods. Asymmetry, border color and diameter (ABCD) approach, seven-point detection methods, Menzies method, and pattern analysis are some of the methods used. The approaches for cancer detection are evaluated using assessment criteria such as ROC, AUC, F1 score, accuracy, and so on. According to them, some study was conducted using other methodologies that were insufficient for better and smarter detection. Their research is separated into two parts: the first looks at how medical imaging is done using machine learning, and the second looks at how different ways of deep learning networks are employed in their research. Their study about breast, lung, brain, and skin cancer has limitations due to its length. They reduced the noise in the preprocessing step because the photographs were raw. They then performed picture segmentation and post segmentation. They then use the ABCD rule, which stands for asymmetry, border, color, and diameter. They claim that when CNN is utilized for detection, it lacks the necessary dataset. They employed data augmentation because there was a paucity of dataset. Another issue they faced was the unequal distribution of training data. Another issue they encountered was the varying size of the target object inside the image. They utilized 15 models to identify the malignancies, 6 of which had previously been published and 9 of which had not. For detection, two of them employed mammograms and eight used CT slices. Volumetric tomography was used in five of them, and seven were used to classify brain cancer.[12]

Sunghwan Yoo et.al, used deep convolutional neural networks to study prostate cancer detection. For prostate cancer identification, they used CAD tools, diffusion weighted magnetic resonance imaging, and various CNN algorithms. They took two steps. They created pipelines at two levels: slice level and patient level. Instead of ROI, automated center cropping was used. They created an automated CNN pipeline for prostate cancer diagnosis. They employed a DWI imaging collection of 427 patients, of which 175 had prostate cancer and 252 did not. To check the model's performance, a test set of

108 patients was set aside and not used in the suggested technique of training set. Based on the AUC and ROC curve, the results were satisfactory. Because their dataset includes a small number of DWI pictures of men with prostate cancer, AUC was chosen as the best tool for evaluating the results. They had 5 different test results at the slice level for the CNN approach, with each outcome for each test. Their best CNN model for slice level accuracy was CNN1, which had an AUC of 87 percent and a ROC of 95 percent. They closed their study with a discussion of future work that may be done to increase accuracy utilizing 3D CNN and recurrent neural networks.[13]

III. Methodology and Pre-Processing of Data

Here we will discuss about the methodologies chosen for our planned study and carry implementation and analysis in depth. The procedures of pre-processing will be thoroughly described. The key step in any project is deciding which designs will be utilized for analysis. CRISP-DM and KDD are the two most widely used approaches. Because CRISP-DM is more focused on gaining business insights and is widely used to generate business value, we will instead employ substitute process called Knowledge discovery in Databases(KDD), which aids in the finding of important knowledge in databases. It aids in the discovery, transformation, and refinement of important data.In KDD process the Data is divided into several groups and lists bases on resemblance of data.KDD is an favourable process because of its constant ability of improvement in providing patterns for the predictions and analysis.As the study includes image classification kDD can provide patterns for identifications.KDD has 5 steps which will discussed in detail.[14] The KDD process is studied and implemented as follows:[15]

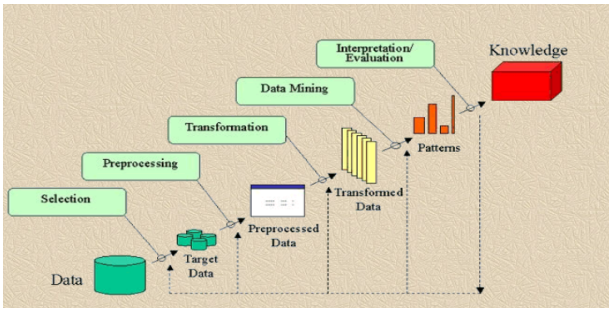

Fig.1. KDD Process

A. Data Selection

Data selection is the first phase in the KDD methodology, where the data on which the research will be conducted is chosen. The dataset for our study comes from Kaggle, which is open source. The collection contains MRI (magnetic resonance imaging) of brain tumors. There are two types of MRIs.

```
augmented_path = 'D:/Semester 2/DMML2/All Files/braintumour_dataset/augmented data/'

# augmented data (yes and no) contains both the original and the new generated examples
augmented_yes = augmented_path + 'yes'
augmented_no = augmented_path + 'no'

IMG_WIDTH, IMG_HEIGHT = (240, 240)

X, y = load_data([augmented_yes, augmented_no], (IMG_WIDTH, IMG_HEIGHT))
```

```
Number of examples is: 2065
Number of examples y : 2065
X shape is: (2065, 240, 240, 3)
y shape is: (2065, 1)
```

Fig.2 Statistical Analysis of Data

1) It has NO images, indicating that there is no tumor.
2) It contains YES images, indicating the presence of a tumor.

B. Data Pre-Processing

Pre-processing, often known as data cleaning, is the second phase in KDD. Model construction begins with pre-processing. We remove outliers, fill in missing values, and other factors that affect the outcome. The images in the dataset are raw, which means they contain a lot of unnecessary data for analysis. So this unwanted data must first be eliminated or modified. The Images in the Kaggle dataset had images that were of varying sizes and shapes, which were adjusted using the cropping approach. Cropping was used to remove irrelevant data and only use that portion of the image data that would be beneficial for analysis. The images are first converted to grayscale, and then minor noise is removed using thresholding. Image cropping is done utilizing extreme points, such as left, right, top, and bottom, and new images are generated. Because the images in the Dataset are of varying sizes and shapes, a normalization procedure was used to standardize them. As a result, the photos are normalized using pixels, where 0 means no and 1 means yes.

```
BTyes_img = cv2.imread('D:\Semester 2\DMML2\All Files\yes\Y15.jpg')
BTyes_new_img = crop_brain_contour(BTyes_img, True)
```

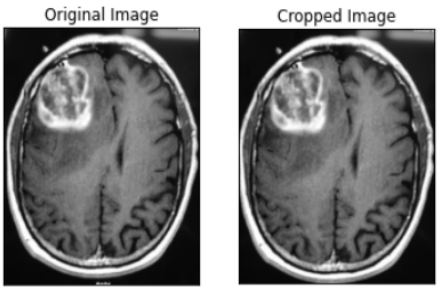

Fig.3 Cropped Image

C. Data Transformation

The 3rd step in KDD is data transformation, where using the pre-processed data is used and modified for analysis of model.

```
def plot_sample_images(X, y, n=50):
    """
    Plots n sample images for both values of y (labels).
    Arguments:
        X: A numpy array with shape = (#_examples, image_width, image_height, #_channels)
        y: A numpy array with shape = (#_examples, 1)
    """

    for label in [0,1]:
        # grab the first n images with the corresponding y values equal to label
        images = X[np.argwhere(y == label)]
        n_images = images[:n]

        columns_n = 10
        rows_n = int(n/ columns_n)

        plt.figure(figsize=(20, 10))

        i = 1 # current plot
        for image in n_images:
            plt.subplot(rows_n, columns_n, i)
            plt.imshow(image[0])

            # remove ticks
            plt.tick_params(axis='both', which='both',
                            top=False, bottom=False, left=False, right=False,
                            labelbottom=False, labeltop=False, labelleft=False, labelright=False)

            i += 1

        label_to_str = lambda label: "Yes" if label == 1 else "No"
        plt.suptitle(f"Brain Tumor: {label_to_str(label)}")
        plt.show()
```

Fig.4.Data Pre-Processed

Here once pre-processing step is done and all the unwanted data is removed and images are fixed in standardized form, the next step was data augmentation. As the dataset for our research had small no of data, data augmentation was performed. Data augmentation is a method that helps to increase the size of data which can be further used for the analysis. By using the current data is creates copies of data creating large number of data that is used in train for the analysis. The original dataset contained 253 of total yes no images for brain tumour. After data augmentation was applied, a total of 2065 images where generated. In the original data, the ratio of no images and yes images where imbalanced. There where 98 images of 'no' and 155 images of 'yes'. This problem was also solved when data augmentation was performed and the final augmented dataset had balanced data of 2065 images with the original 253 images.

```
X_train, y_train, X_val, y_val, X_test, y_test = split_data(X, y, test_size=0.3)
```

```
print ("number of training examples = " + str(X_train.shape[0]))
print ("number of development examples = " + str(X_val.shape[0]))
print ("number of test examples = " + str(X_test.shape[0]))
print ("X_train shape: " + str(X_train.shape))
print ("Y_train shape: " + str(y_train.shape))
print ("X_val (dev) shape: " + str(X_val.shape))
print ("Y_val (dev) shape: " + str(y_val.shape))
print ("X_test shape: " + str(X_test.shape))
print ("Y_test shape: " + str(y_test.shape))
```

```
number of training examples = 1445
number of development examples = 310
number of test examples = 310
X_train shape: (1445, 240, 240, 3)
Y_train shape: (1445, 1)
X_val (dev) shape: (310, 240, 240, 3)
Y_val (dev) shape: (310, 1)
X_test shape: (310, 240, 240, 3)
Y_test shape: (310, 1)
```

Fig.5 Data Augmented

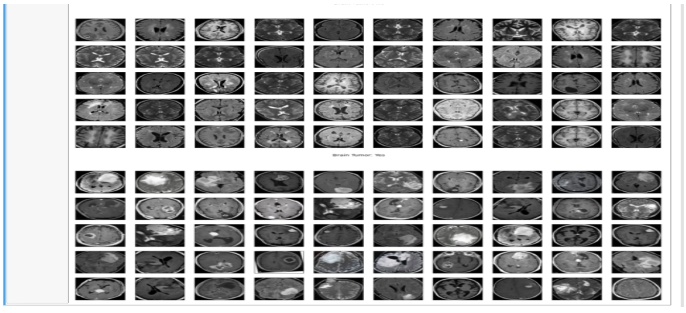

Fig.6. Pre-Processed Images

This data is converted into array using Numpy which is then used for our analysis. Then this data is split into train and test data in ratio 70:15:15 and on which further analysis is done and required model is applied.

D. Data Mining

The step 4 in the KDD approach is data mining. In this step, we apply the required models to our modified data and extract the key insights for analysis. The model is chosen and implemented based on the dataset and the expected outcome. CNN convolution neural network and VGG16 model were the models we chose for our research and thought would be the best fit for the analysis.

1) Convolutional neural network (CNN): It is a deep learning method for image categorization that is widely utilized. It's a form of neural network that takes raw images, trains it, and then extracts characteristics for classification. CNN has an advantage over others since it recognizes crucial qualities without the need for human intervention. Another element is the CNN filter, which is an important factor in determining efficiency. In Cnn model building Implementation of the model is done after pre-processing and data is split into train and test sets. We used various processes for our model using which implementation will be done. Using the various process, the implementation for the model building will be done. The first input shape is applied. Input shape is something that represents the shape of the model input which includes image width, and image height) Followed by zero-padding, then activation called as relu was also applied, Another Layers in convolution network such as Maxpool, and Flatten were applied. Later the model complied with the training.

- Max pool: Max pooling is a layer in a Convolutional neural network that converts an image to a matrix and extracts some features that are then used for max pooling. It aids in the reduction of image size, resulting in fewer parameters and the retrieval of more useful insights and results. It also aids in lowering the cost of the computational process. Like most cases, Max filters are used.
- Convolutional 2D: The kernel of a convolutional 2D matrix is the first step. The image is said to be in matrix form, with primarily 2D input data, which after processing results in converting the performing result into a single output pixel. Kernels also repeats the entire process in each location. As a result, it aids in the conversion of the 2D matrix into another 2D matrix. This means that the size of the kernel directly influences how many input features are merged to create a new output feature.[17]
- Flatten layer-It is a convolution neural network, generally converts the matrix into a one-dimensional array, which means they use the flatten technique hence when the whole matrix gets converted into one single column later, it gets ready to pass its input in the next layer for further processing.
- Zero Padding- is also a layer that is associated with the pixel it generally tries to keep the size of the input and output data the same by adding some extra columns and rows in the corners. Padding generally expands the

image size which helps in convolution image processing. Padding is referred to as the same padding, causal padding, and valid padding.ReLU it is used for activation. Other layers like dense, convo2D, normalisation are seen for the analysis.

2) VGG16: VGG16 is par't the of convolution neural network by adding on some extra features which make it more robust. It is said that in the ImageNet dataset VGG16 is the fit best model. It goes under a variety of layers which is responsible for model performance. With the activation such as relu which helps in passing the image from convolution layers thus, it contains around 64 filters thus, the gridPlotImage function was defined, followed by cropping the image, taking extreme points, searching for contours in the threshold image, and finally plotting the image. As a result, these steps are critical in image preparation. As previously stated, data augmentation was also implemented, giving us more room for training data to perform. In order to use the VGG16 model, we must first apply a few TensorFlow packages and libraries such as RMSprop, Adam, VGG16, and Early Stopping. When the VGG16 model was implemented, a few extra functions were added, such as flatten, which is in one-dimensional vector form and converts the array for forwarding to the next layer. Other layers implemented were a dropout and dense layer. Later, we performed Model fitting where we fit the train data from the python generator which is one of the most convenient ways of training the models. Following model performance and accuracy we performed the VGG16 model in our dataset which is our second model.

E. Performance Metrics

1) Confusion Matrix:: Confusion matrix is a 2 x 2 matrix that is commonly used in model evaluation. It's a typical matrix that's utilized to solve classification difficulties. It displays both predicted and actual values. True Negative indicates negative numbers, True Positive indicates positive numbers, False Positive indicates that the actual number for negative is classed as positive, and False Negative indicates that the actual positive is categorized as negative.

The number of images with tumor cells is indicated by TP. TN refers to images that are free of tumor cells. FP indicates images that are incorrectly classified having tumour cells but are healthy and FN indicates images that have tumour cells but are classified as healthy.

		Predicted	
Actual		Negative	Positive
	Negative	TN	FP
	Positive	FN	TP

Fig.7. Confusion Matrix

Performance metrics also consists of accuracy, precision, recall and F1 score which by using the above 4 output values these are calculated.

2) Accuracy: It is the foundational model that is utilized to predict the model. By looking at the accuracy, we can say that the model has performed better and is successful. Accuracy is calculated by multiplying the right prediction by the total number of predictions.

$$\frac{\text{True Positives + True Negatives}}{\text{True Positives + True Negatives + False Positives + False Negatives}} = \frac{\text{N. of Correct Predictions}}{\text{N. of all Predictions}} = \frac{\text{N. of Correct Predictions}}{\text{Size of Dataset}}$$

Accuracy Formulas. Image by Author.

Fig.8. Precision Metrics

3) Precision: Precision is another evaluation method used as performance metrices. The precision is done by calculating the positive values upon total number of true positive and negative.

$$\boldsymbol{Precision = \frac{True_{positive}}{True_{positive} + False_{positive}}}$$

Fig.9. Precision

4) Recall: Another evaluation approach that classifies more than two classes is recall. The higher the recall, the higher the detection of positive samples, implying that we can use these measures to predict.

$$\boldsymbol{Recall = \frac{True_{positive}}{True_{positive} + False_{negative}}}$$

Fig.10. Recall

5) F1 score: F1 score is nothing but mean of precision and recall. F1 score is also called F score. Higher is the precision and recall higher is the F1 score. If F1 score is 1 or closer to 1, it is said that the model is better and highly accurate.[16]

The F_1 Score is given by :

$$F_1 = 2 * \frac{Precision * Recall}{Precision + Recall}$$

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Fig.11. F1 Score

IV. Selection of Models

In this section, selection of model was done on the basis of performance of models implemented.The study was done by using two deep learning models which were Convolutional Neural Network(CNN) and VGGS16.The factors considered for selection of best suited model are nature of the Dataset,patterns created in pre-processing,Evaluation results based on Confusion matrix(types of errors),Accuracy and Validation loss.When performed CNN model provided to most significant model showing high accuracy and less validation loss.The main drawback faced by VGG16 was it is very slow to train and has large bandwidth in network architecture.In CNN the confusion matrix showed less type 1 and type 2 errors.The vital reason in choosing CNN is its ability of using filter which increases its efficiency in identifying patterns and detect tumour cells which makes it best suited model for the detection of Brain tumour.

V. Result

This section includes the evaluation of applied Deep learning models on the Pre-Processed Dataset.The evaluation process directly depends upon the execution of the models.The deep learning models used in this study were Convolutional Neural Network(CNN) and VGGS16.All the models were successfully implemented and thus the analysis of the result will be used to test the performance of the model base on different evaluation techniques.The Dataset was first split into training and test sets.Further the training set was used to built model by using model.fit function.The CNN model is tested on the following evaluation techniques.

```
print (f"Test Loss = {loss}")
print (f"Test Accuracy = {acc}")
```

```
Test Loss = 0.30018651485443115
Test Accuracy = 0.8935483694076538
```

Fig.12. Test accuracy and Validation loss

The model was trained by using forward and backward passing called epoch.The whole training model was trained using 17 epochs.The model was trained with increasing number of epochs initially with 8 and then increase by 3 epochs 3 times.When the data was trained with 87% . But as we increase the epoch the accuracy of the model increase up to 89% and validation loss of 30% which makes it best suited model for analysis.The accuracy of the model increased with more number of epoch thereby reducing the validation loss.

F1 score for Test Set

```
In [39]: y_test_prob = best_model.predict(X_test)
         f1score = compute_f1_score(y_test, y_test_prob)
         print(f"F1 score: {f1score}")

         F1 score: 0.9080779944289693
```

F1 score for validation Set

```
In [40]: y_val_prob = best_model.predict(X_val)
         f1score_val = compute_f1_score(y_val, y_val_prob)
         print(f"F1 score: {f1score_val}")

         F1 score: 0.8753623188405797
```

Fig.13. F1 Test set and F1 validation set

Second to this,To make the model more reliable with the accuracy , F1 score for test set and validation set was checked. The F1 score for test set was 0.90 and validation test is 0.87.As the value is near to 1 the model performance increases.

```
Val Accuracy = 0.91

array([[134,  13],
       [ 14, 149]], dtype=int64)
```

Fig.14. Confusion Matrix

```
Recall For Test->
43.871 %
Precision For Test-->
19.247 %
Recall For Val->
47.419 %
Precision For Val-->
22.486 %
```

Fig.15 Precision and Recall value

The next evaluation technique use is for observing the confusion matrix.By examining the confusion matrix it can be concluded that the Type 1(false positive) and Type 2(false negative) are less in comparison to total count of sets. The accuracy is high with 91% and Recall value close 50% (43%). The multiple evaluation were successfully achieved by CNN model which makes the model best suited for the detection of Brain tumour.

VI. Conclusion and Future Work

A Deep Learning system was introduced for the classification of medical images using training images for the detection of brain tumor.The traditional methods of diagnosis in medical sector such as inspection and X-Rays are very much time consuming as well can't produce favourable results.Hence, the purposed Deep learning system aims in aiding help for the diagnosis of Brain tumor by doing image classification.This deep convolution network provides automation without much time to analyze medical images and take further decision accordingly.In this study, the medical images having structural feature were selected as Data which was further pre-processed by using Data Mining techniques.The pre-processed data then undergoes into implementation phase where two deep learning algorithm were selected which depends upon nature of the Data.The two model were CNN and VGG16.After successful implementation of algorithms the next vital process was done by evaluating the results based one certain criteria such as accuracy and validation loss, F1 score and Confusion matrix.After evaluation due to high values of CNN and performance measure it was selected as best suited model for the detection of Brain tumor.

In future work, the classification of images can be done by using coloured images which can be more helpful in showing patterns.The same study can be performed by using other Deep learning models which might give more efficiency, cleared images and high accuracy for prediction and analysis.

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