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Predicting Meningioma Using Inception and Efficient Net Algorithms

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Abstract - Meningioma is the most common primary brain tumor, accounting for more than 30% of all brain tumors. Meningiomas originate in the meninges, the outer three layers of tissue that cover and protect the brain just under the skull. Women are diagnosed with meningiomas more often than men. About 85% of meningiomas are noncancerous, slow-growing tumors. Almost all meningiomas are considered benign, but some meningiomas can be persistent and come back after treatment. This LGG is treated with a combination of surgery and examination by monitoring the meningioma with brain MRI scans. The study of this project enabled us to build a fully automated system for segmentation of meningioma utilizing computer vision techniques, and developing models that would allow high-quality LGG identification in the brain MRI would potentially be automated to identify the genomic subtype of the meningioma by rapid and inexpensive imaging. The methods, techniques, advantages and their limitations and their future challenges are discussed in this project..

Key Words: LGG, MRI,Inception,Efficient Net,CNN

1.INTRODUCTION

Meningioma is the most common primary brain tumor, accounting for more than 30% of all brain tumors. Meningiomas originate in the meninges, the outer three layers of tissue that cover and protect the brain just under the skull. Women are diagnosed with meningiomas more often than men. About 85% of meningiomas are noncancerous, slow-growing tumors. Almost all meningiomas are considered benign, but some meningiomas can be persistent and come back after treatment.

A current cancer study dis- covered a new study known as radio-genomics. These cutting edge medical procedures aid in the accurate research of malignancies. The advancement of artificial intelligence techniques works together to solve these tumour identifications.

Expert systems have a wide range of effective applications, particularly in the medical arena. These expert algorithms have even outperformed professional radiologists in several cases.
Deep learning-based automatic segmentation approaches have yielded considerable results in recent years. Convolutional Neural Networks are the most renowned and verified deep learning models for extracting characteristics that are advantageous in real-time classification given the original data. Given its established outcomes and accomplishments, the medical brain tumor segmentation shifted its focus to deep learning.

2. BODY OF PAPER

A **brain tumor** (sometimes referred to as **brain cancer**) occurs when a group of cells within the brain turn cancerous and grow out of control, creating a mass. There are two main types of tumors: malignant (cancerous) tumors and bengin (non-cancerous) tumors. These can be further classified as primary tumors, which start within the brain, and secondary tumors, which most commonly have spread from tumors located outside the brain, known as brain metastasis tumors. All types of brain tumors may produce symptoms that vary depending on the size of the tumor and the part of the brain that is involved. Where symptoms exist, they may include headaches, problems with vision, vomiting and mental changes. Other symptoms may include difficulty walking, speaking, with sensations.

The cause of most brain tumors is unknown, though up to 4% of brain cancers may be caused by CT scan radiation. Uncommon risk factors include exposure to vinyl chloride. Studies on mobile phone exposure have not shown a clear risk. The most common types of primary tumors in adults are tumors (usually benign) .

Treatment may include some combination of surgery, radiation therapy and chemoptheraphy.

Secondary, or metastatic, brain tumors are about four times as common as primary brain tumors, with about half of metastases coming from lung cancer. Primary brain tumors occur in around 250,000 people a year globally, and make up less than 2% of cancers. In children younger than 15, brain tumors are second only to as the most common form of cancer. In New South Wales, Australia in 2005, the average lifetime economic cost of a case of brain cancer was AU$1.9 million, the greatest of any type of cancer.

Table -1:

Year/Author	Algorithms	Methodology	Merits	Remarks
Patel et al. (2020)	CNN (U-Net)	Used deep learning for segmentation of brain MRI scans	High accuracy in tumor localization	Requires large annotated datasets
Sharma et al. (2021)	DeepLabV3+	Improved segmentation using atrous convolution and skip connections	Enhanced feature extraction and segmentation	Computationally intensive
Lee et al. (2022)	Hybrid CNN-Transformer	Combined CNNs for feature extraction and transformers for global attention	Improved accuracy and robustness	Higher computational complexity
Kumar et al. (2023)	Vision Transformers (ViTs)	Transformer-based segmentation of brain tumors in MRI images	Effective in capturing long-range dependencies	Needs large-scale datasets for optimal performance

INPUT IMAGE:
The input image taken from the kaggle dataset was in .tif format. Although the image format is not in JPEG or PNG, the format can be directly used for training without any conversions. Also, the size of the image was 256*256, which is a minimized and preferred size for most deep learning models.

PRE-PROCESSING:
It is used to improve the quality of the digital image, especially poor image quality such as images with too much noise, specifically blurriness. To remove the noise we use Keras library, which helps in preprocessing the image based on the model we choose.

SKULL STRIPPING:
It is used to remove the unwanted or the unnecessary regions of the MRI image. It helps in identifying the pattern of the tumor while training the digital images.

DETECTION PROCESS:
In the detection process, to detect the tumor of any given bio-medical image, we have used the transfer learning technique to classify the image. ResNet50 and VGG16, both were used during the model training.

CLASSIFICATION:
Abnormality of an image is determined by classification in essence abnormal or normal. There are many classifiers but the neural network is one of the most prominent classifiers that differentiate between images affected with tumors or normal medical images. There will be intensity associated with the affected image; the neural network model then compares the given image with the images present in the database.

SEGMENTATION:
Given that, the brain tumor images and their corresponding masks are present in less number, 3929 samples each, we have used the Keras ImageData- Generator class in order to increase the dataset size. This process is also known as Data Augmentation. Also, in this step, we have resized the images into 256x256x3. The dataset is normalised before feeding it to the model. 11 Later, this data is fed into the deep neural network model for building a segmentation model.

EXISTING BLOCK DIAGRAM:

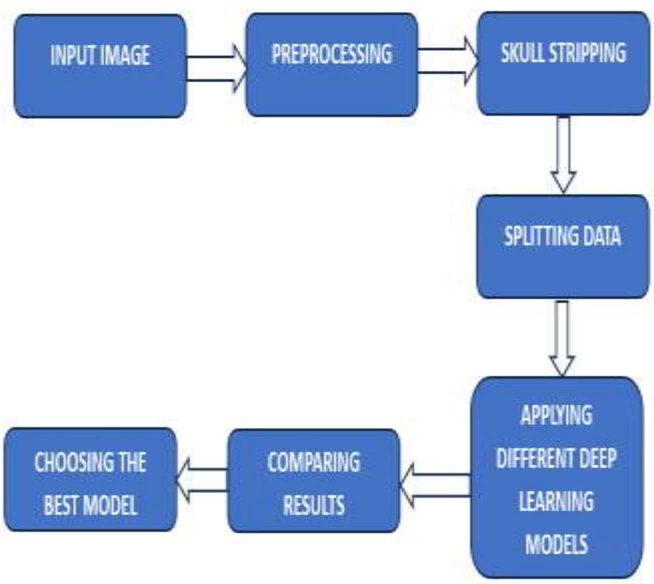


Fig -1:

Second rate gliomas are normally treated with a mix of a medical procedure, perception, and radiation. In the event that the tumor is situated in a zone where it is protected to eliminate, at that point the neurosurgeon will endeavor to eliminate however much as could be expected.

Now and then this is all the treatment you will require toward the start and your primary care physicians will screen your tumor with MRI checks at regular intervals. In the event that the tumor seems, by all accounts, to be developing, your PCPs will at that point consider either performing another medical procedure or beginning therapy with radiation. There is no demonstrated job for chemotherapy in treating poor quality gliomas, however when the tumor develops regardless of radiation and chemotherapy, your primary care physicians may choose to utilize it. Regardless of whether the whole noticeable tumor is taken out at a medical procedure, there are typically some tumor cells that have attacked adjoining portions of the cerebrum.

These cells can develop and make the tumor return. Ultimately, most second rate gliomas will proceed to develop and afterward form into a higher evaluation tumor, for example, the evaluation 3 or evaluation 4 tumors. Determination of LGGs is made through a blend of imaging, histopathology, and sub-atomic demonstrative strategies. On a registered tomography filter, second rate gliomas show up as diffuse zones of low constriction. On customary attractive reverberation imaging (MRI), which is as of now the imaging methodology of decision, LGGs are frequently homogeneous with low sign force on T1-weighted successions and hyperintensity on T2-weighted and Fluid-Attenuated Inversion Recovery (FLAIR) groupings.

HISTOPATHOLOGY:
The tissue test is stained utilizing hematoxylin and eosin, which takes into consideration distinguishing proof and arrangement of tumor type. Diffuse astrocytomas consist of very much separated fibrillary or gemistocytes neoplastic astrocytes on a free network. Oligoastrocytomas are diffusely penetrating tumors with a combination of oligodendroglial and astrocytic cell types. Oligodendrogliomas are invading tumors containing cells with uniform-showing up cores and perinuclear clearing, frequently portrayed as having a "singed egg" appearance

SURGERY:
In one survey of the careful administration of LGG, the creators noticed the authentic contentions for attentive holding up in chose patients with insignificant or medicinally controlled indications, with one of the essential contentions dependent on information proposing that such a methodology didn't deteriorate patients' QoL, nor did it adversely affect generally speaking endurance, albeit the estimation of such information is restricted by its review nature.

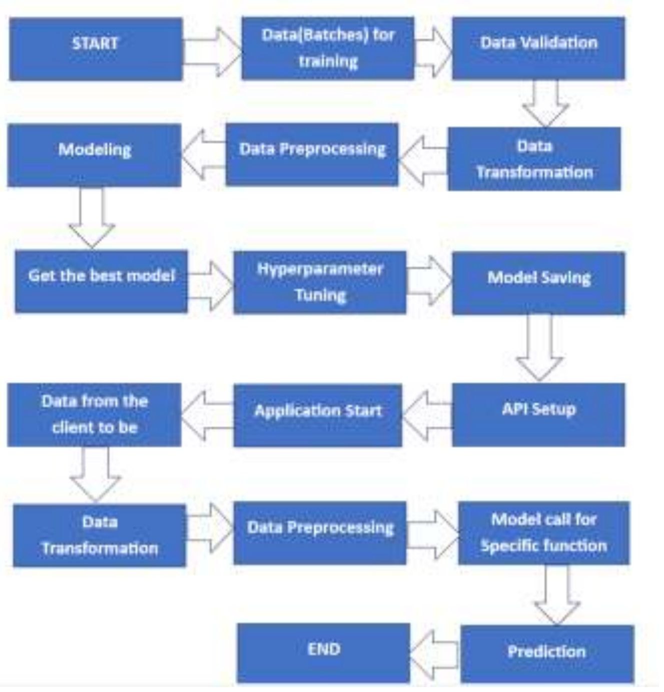
RADIATION:
A few forthcoming clinical preliminaries have analyzed the utility of high-portion versus low-portion radiation and the expenses versus advantages of early versus postponed radiotherapy. In EORTC 22844, examiners evaluated the general adequacy of radiotherapy and the capability of a portion reaction relationship. An aggregate of 379 grown-up patients with LGG was randomized to get radiotherapy postoperatively (or postbiopsy) with 45 Gy in 5 weeks versus 59.4 Gy in 6.6 weeks. At a middle development of 74 months, there was no huge contrast in by and large endurance (58% in the low-portion

gathering and 59% in the high-portion gathering) or movement free endurance (47% in the low-portion gathering and half in the high-portion gathering), and there was no obvious portion reaction relationship for radiotherapy in LGG.

CHEMOTHERAPY:
In spite of the fact that chemotherapy is frequently utilized in high-grade gliomas, its part, with or without radiation treatment, in the therapy of patients with LGG stays a subject of examination. Given its exhibited viability in the high-grade glioma populace, temozolomide has been specifically noteworthy. In one stage II investigation, there was exhibited movement of temozolomide in LGG patients with reformist sickness. In this accomplice of 46 patients, 61% of subjects accomplished radiographic reactions—24% having accomplished total reaction and 37% having accomplished fractional reaction. The middle movement free endurance (PFS) was 22 months, with a 6-month PFS of 98% and a year PFS of 76%.

MONITORING RESPONSE TO TREATMENT:
The ideal technique for surveying treatment reactions in LGG stays a functioning region of examination. Presently, MRI (T2/FLAIR succession), with or without contrast improvement, is utilized to recognize tumor size and related peritumoral edema. A few creators recommend that treatment results may be all the more dependably assessed utilizing progressed imaging methods intended to evaluate explicit organic parts of the tumor, including amino corrosive PET..

PROPOSED BLOCK DIAGRAM:



We approached this project to learn more about the DEEP NEURAL NETWORKS not merely to sneak the code from tutorials and use correct syntaxes to build something. With this in mind, first we developed a lot of programs using Python, CNN modules with both the high level and the low level programming in essence, using the Keras and Tensorflow libraries which implements different aspects of the neural network ability and which were totally related to our project. Among those implementations of the Sequential model, transfer learning of the bottleneck features gave clear conclusions and documentation also helped a lot.

3.SYSTEM ARCHITECTURE

The proposed system is to develop an automatic system that has a built-in classification model and a segmentation model. The first part of building the model is pre-processing and then split into training, testing, and validation data. The data is further trained using multiple models and their respective results are compared after which the best model is used for further classifications. Similar procedure is carried out for building the segmentation model.

The proposed methodology includes following tasks, in essence, dataset splitting, dataset transfor- mation, hyperparameter tuning, modeling. Further details of each task are discussed below.

1) DATA SPLITTING:
In general, there are various ways of splitting the data based on the given data. The dataset is spitted using hold-out technique, in essence 85% of training data and 15% of testing or validation data, considering the fact that the data set used in this study isn't biased and has almost equal amount of classes.Also, we have not used any stratification algorithms.

2) PREPROCESSING OF DATA:
Digital pictures vary significantly in terms of picture size. Hence all the images are scaled to a common frame of reference depending upon the model we are using. As our emphasis is majorly on the brain region, unnecessary regions of the skull are removed (a.k.a., Skull 14 Stripping). In the end, the dataset is normalized using the Z-score. Once these steps are accomplished, the dataset is split into training, testing, and validation.

3)BUILDING DIFFERENT CLASSIFICATION MODELS:
Two deep learning models are built using VGG16 [20] and ResNet50. Although, the base model was built using the multilayer perceptron and used transfer learning in order to increase the performance of the model. The models are built by taking care of overfitting and underfitting cases while they are monitored and are evaluated using classification evaluation metrics. Early Stopping and loss monitoring call-backs were also used while training the model.

4) SEGMENTATION MODELING:
In general, the Unet architecture proposed by Olaf Ronneberger is proven the best for segmentation tasks. The residual blocks in the unet architecture helps the CNN model to get significant results. In this study, we proposed a hybrid architecture blend-ing the residual blocks and the Unet architecture and we call it ResUnet.

There are various evaluation metrics for the classification model. Here are the few that we have considered. In this study we have used Tversky loss function in order to make evaluation more fault free. This loss function has parameters that can be optimized to get significant results by penalising the loss function. This loss function contains constants 'alpha' and 'beta' to act as penalising factors in case of false positives and false negatives.In our study we have used

$\alpha = 0.7$

1)Accuracy:
Accuracy refers to the ratio of the instances that are correctly classified to the total number of instances. It is used to evaluate the classification model when the data is balanced.

Here's the formula Accuracy = (TP + TN) / (TP + TN + FP +FN)
FN–False Negative,
FP– False Positive,
TN– True Negative,
TP– True Positive.

2) Recall:
Recall refers to the ratio of true positives to the sum of true positives and false negatives. This evaluation metric is used as we want to check the efficiency of false negatives. Here's the formula 33

Recall = TP / (TP + FN)

3)Confusion Matrix :
A Confusion matrix is a 2 X 2 matrix which quantifies about all the possible outcomes of the classification model, in essence, the true positive, true negative, false positive, and false negative.

Implementation Steps for implementation

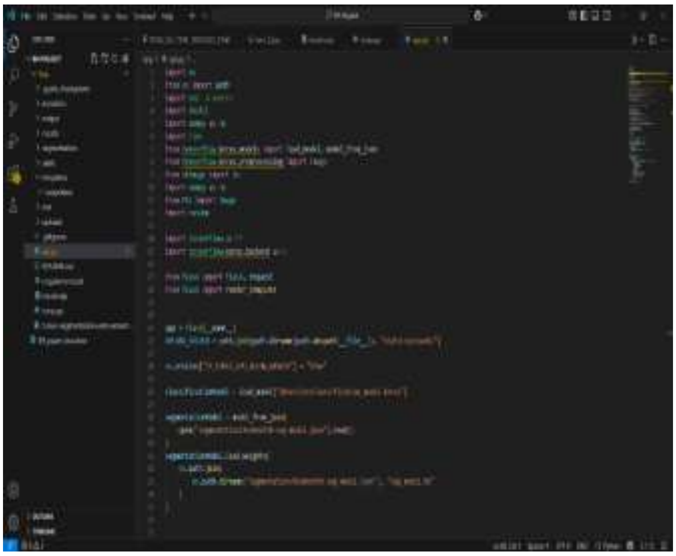
1.Install Required Software & Tools Install Required Software & Tools

2 Set Up a Virtual Environment

3 Install Dependencies (tensorflow keras opencv python matplotlib pandas) .

4 Download & Preprocess the Dataset.

Figure 1,2,3:Training the Model:



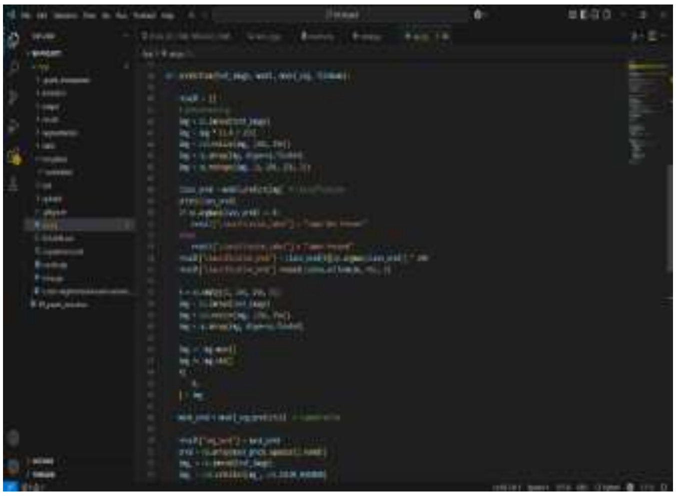
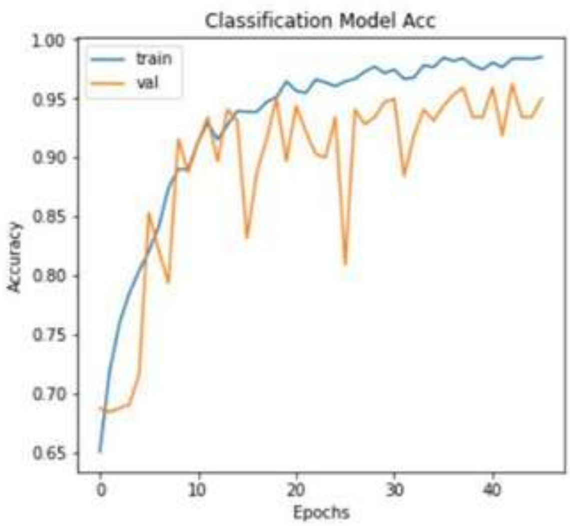


Figure 3:Frontend of applications:



4. CONCLUSION

In this project, we proposed a novel ResUnet architecture to extract more features efficiently on brain tumor segmentation data. The model architecture can be improved by adding more frameworks with multiple residual blocks at both the contraction and the expansion paths. Therefore, our future work is to look into more detailed features and also identify the grade of tumor based on the segmented tumor shape..

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