Multi-Class Brain Tumor Classification using Hybrid Models

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What is the problem?

Detection and Classification of Brain tumor cells from images of MRI using various ML Algorithms. Here we will design several classification models and evaluate their performances. The model classifies the image into four categories (glioma, pituitary, meningioma, and no tumor)

Why is it interesting?

The machine learning-based approaches like Deep ConvNets in radiology and other medical science fields play an important role to diagnose the disease in a much simpler way as never done before and hence providing a feasible alternative to surgical biopsy for brain tumors. In this project, we attempted at detecting and classify the brain tumor and compare the results of this classification of brain tumors using various machine learning architectures such as KNN, SVM, Random Forest, and Convolutional Neural Networks.

Why is it hard? (Why do naive approaches fail?)

An effective and efficient analysis to spot Brain tumor is always a key concern for the radiologist in the premature phase of tumor growth. The biopsy procedure requires the neurosurgeon to drill a small hole into the skull from which the tissue is collected. There are many risk factors involving the biopsy test, including bleeding from the tumor and brain causing infection, seizures, severe migraine, stroke, coma and even death. The proper visualization of the tumor cells and its differentiation with its nearby soft tissues is somewhat difficult task which may be due to the presence of low illumination in imaging modalities or its large presence of data or several complexity and variance of tumors-like unstructured shape, viable size and unpredictable locations of the tumor. Therefore, development of systems for the detection and classification of the severity of tumors based on MRI data has become necessary.

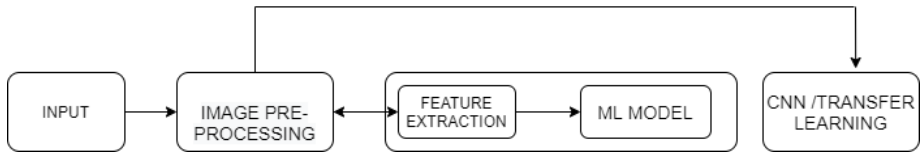
Why hasn't it been solved before (or, What's wrong with previously proposed solutions? How does mine differ?)

The most common method of image pre-processing often involves image augmentation[1]. Image augmentation is the method of increasing the dataset by applying one or more transformations on the images (such as zooming, flipping over the axes, rotation. Most of the methods above use Otsu's method to separate background and use wavelet transform[2]. After processing in similar way, many researchers have tried to solve the problem using simple ML models – KNN[3], Logistic Regression[4], SVM[5], and Random Forests[6]. The noise in MR images is due to the fluctuations of the magnetic field in the coil. Magnetic Resonance Imaging is corrupted by Rician noise. Rician noise makes quantitative measurements difficult. Therefore, obtaining high-quality denoising images is the most important task of pre-processing. Median filters are effective against such noise. The above methods do not implement median filters. We use multiple morphological operations for masking from OpenCV. PCA is then used for feature selection, so that the feature space gets reduced. The reduced features space is then used in several machine learning models (KNN, RF, SVM). All these models are then compared with Deep Learning models: manually built CNNs, and pre-built CNNs (transfer learning).

What are the key components of my approach and results? Also, include any specific limitations.

Key components of the approach:

1. **Input**
2. **Pre-Processing**
    a. **Feature Extraction**
    b. **ML Model (KNN, SVM, Random Forest)**
3. **CNN/Transfer Learning**



Expected Results and Limitations: We expect Deep Learning models to perform better than naïve ML models. The limitations might be the presence of low-quality images in the dataset. Medical datasets require images to be of highest quality. Plus, some trivial information might get lost in feature selection process. So, the process is not completely lossless.

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[1] Sultan, H.H., Salem, N.M., & Al-Atabany, W. (2019). Multi-Classification of Brain Tumor Images Using Deep Neural Network. *IEEE Access, 7*, 69215-69225.

[2] Garg, G., & Garg, R. (2021). Brain Tumor Detection and Classification based on Hybrid Ensemble Classifier. *ArXiv, abs/2101.00216*.

[3] Aiwale, P., & Ansari, S.M. (2020). Detection of Brain Tumor using KNN and LLOYED Clustering.

[4] Żurek, Grzegorz & Błach, Michał & Giedziun, Piotr & Czakon, Jakub & Fulawka, Lukasz & Hałoń, Łukasz & Krajewski, Piotr & Dyrka, Witold. (2015). Brain tumor classification using logistic regression and linear support vector classifier.

[5] T. S. Kumar, K. Rashmi, S. Ramadoss, L. K. Sandhya and T. J. Sangeetha, "Brain tumor detection using SVM classifier," 2017 Third International Conference on Sensing, Signal Processing and Security (ICSSS), 2017, pp. 318-323, doi: 10.1109/SSPS.2017.8071613

[6] O. Meet, and R. Kapdi, "Brain Tumor Disease Identification Using Random Forest Classifiers," 2015 IJCSC Volume 7 Number 1, pp.202-204