Winter in Data Science

Brain Tumor Detection

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Project Report: Convolutional Neural Network (CNN) for Brain Tumor Detection

Executive Summary:

This project focuses on the application of Convolutional Neural Networks (CNN) for the detection of brain tumors from medical imaging data, specifically Magnetic Resonance Imaging (MRI) scans. The primary objective is to develop an accurate and efficient model that can assist medical professionals in the early diagnosis of brain tumors, thereby enhancing treatment outcomes and patient care.

Project Overview:

Background:

Brain tumors are a critical health concern, and early detection is crucial for effective treatment. Traditional methods of brain tumor detection often rely on manual examination of medical images, which can be time-consuming and subject to human error. CNNs, being a powerful deep learning technique, have shown promising results in various image recognition tasks, making them an ideal candidate for automated tumor detection in medical imaging.

Objectives:

1. Develop a CNN-based model capable of accurately detecting brain tumors in MRI scans.

2. Train the model on a diverse dataset to ensure robustness and generalization.

3. Evaluate the model's performance in terms of accuracy, sensitivity, and specificity.

4. Create a user-friendly interface for medical professionals to interact with the developed model.

Methodology:

Dataset:

A diverse dataset of MRI scans, including both tumor and non-tumor cases, was used for training and testing the CNN model. The dataset was preprocessed to standardize image sizes, normalize pixel intensities, and augment data for improved model generalization.

Model Architecture:

The CNN architecture comprised multiple convolutional layers with pooling, followed by fully connected layers. The model was designed to extract hierarchical features from input MRI images, enabling it to discern patterns associated with brain tumors.

Training:

The model was trained using a combination of loss functions and optimization techniques. Transfer learning from pre-trained models, such as VGG16 or ResNet, was explored to leverage their feature extraction capabilities. The training process involved fine-tuning the model on the specific brain tumor dataset.

Results:

Performance Metrics:

The model's performance was evaluated using standard metrics, including accuracy, sensitivity (recall), specificity, and precision. The evaluation demonstrated the model's ability to accurately identify both tumor and non-tumor cases, with a focus on minimizing false positives and false negatives.

Validation:

To validate the model, a separate set of MRI scans not used during training was employed. The validation results were consistent with the training metrics, affirming the model's robustness and generalization capability.

Conclusion:

The project successfully implemented a CNN-based approach for brain tumor detection in MRI scans. The developed model exhibited high accuracy and demonstrated potential for aiding medical professionals in timely and accurate diagnosis. Future work may involve refining the model architecture, exploring additional datasets, and collaborating with medical institutions for real-world deployment.