Machine Learning Engineer Nanodegree

Capstone Proposal

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PROPOSAL

Domain Background

A brain tumor occurs when abnormal cells form within the brain. There are two main types of tumors: malignant or cancerous tumors and benign tumors. Cancerous tumors can be divided into primary tumors that start within the brain, and secondary tumors that have spread from somewhere else, known as brain metastasis tumors.

Magnetic Resonance Imaging (MRI) is the most common diagnostic tool brain tumors due primarily to its noninvasive nature and ability to image diverse tissue types and physiological processes. MRI uses a magnetic gradient and radio frequency pulses to take repetitive axial slices of the brain and construct a 3-dimensional representation. Each brain scan includes 155 slices, with each pixel representing a $1mm^3$ voxel.

Proposal Statement

Brain tumor segmentation seeks to separate healthy tissue from tumorous regions such as the advancing tumor, necrotic core and surrounding edema. This is an essential step in diagnosis and treatment planning, both of which need to take place quickly in the case of a malignancy in order to maximize the likelihood of successful treatment. Due to the slow and tedious nature of manual segmentation, there is a high demand for computer algorithms that can do this quickly and accurately.

Datasets and Inputs

BraTS 2017

Ample multi-institutional routine clinically-acquired pre-operative multimodal MRI scans of glioblastoma (GBM/HGG) and lower grade glioma (LGG), with pathologically confirmed diagnosis is provided as the training, validation and testing data in this dataset. These multimodal scans describe:

a) native (**T1**) and

b) post-contrast T1-weighted (**T1Gd**)

c) T2-weighted (**T2**), and

d) T2 Fluid Attenuated Inversion Recovery (**FLAIR**) volumes

These were acquired with different clinical protocols and various scanners from multiple (n=19) institutions. All the imaging datasets have been segmented manually, by one to four raters, following the same

annotation protocol, and their annotations were approved by experienced neuro-radiologists. Annotations comprise the GD-enhancing tumor (ET — label 4), the peritumoral edema (ED — label 2), and the necrotic and non-enhancing tumor (NCR/NET — label 1), as described in the BraTS reference paper, published in IEEE Transactions for Medical Imaging. The provided data are distributed after their pre-processing, i.e. co-registered to the same anatomical template, interpolated to the same resolution (1 mm^3) and skull-stripped.

Solution Statement

The central theme of the project is to classify the MRI scans using CNNs. This involves testing models built from scratch and fine tuning using pre-trained models using transfer learning.

Benchmark Model

The various models will be compared among themselves and also with the scores available on ‘http://braintumorsegmentation.org/’ i.e. the official website for MICCAI Brats Challenge series.

Evaluation Metrics

The evaluation metrics used is ‘Dice Score or Dice Coefficient’ as it has been used in the official MICCAI Brats challenge series.

Project Design