Determining the Optimal MRI Sequence for the Automatic Segmentation of Multiple Sclerosis Using Convolutional Encoder Networks

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Multiple Sclerosis (MS) is a neuroinflammatory demyelinating disease that affects over 2,000,000 individuals worldwide. Although the exact etiology of the disease is unknown, the main symptoms result from the degradation of the myelin sheath surrounding neurons in the central nervous system (CNS), resulting in white matter lesions that can be identified through the segmentation of diagnostic magnetic resonance images (MRIs). The process for manually segmenting MRI sequences to detect lesions is very time-intensive. Expert raters spend a great amount of time hand labeling individual slices of T1-weighted, T2-weighted, and FLAIR MRIs to obtain a consensus image. In response, machine learning models have been built to reduce segmentation time by automatically detecting lesions. However, many models still use multiple MRI modalities, since the time spent to obtain each type of MRI is not considered in other studies. The goal of this research is to use Convolutional Encoder Networks (CENs) to reduce the segmentation time and achieve robust segmentation using only one MRI sequence as the input. Because of its ability to differentiate between white matter and cerebrospinal fluid (CSF), FLAIR images were hypothesized to yield the best segmentation performance. Based on the Dice Similarity Coefficient (DSC) and Intersection over Union (IoU) scores, each of the four models investigated obtained the best testing metrics and training trends when using only the FLAIR modality; the U-NET CEN obtained the best average DSC of 0.6678 and the U-NET++ CEN obtained the best case DSC of 0.8250, which is in the range of human performance.

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