A 3D Spatial Weighted Model for Brain Tissue Segmentation on Multi-modality MR Images

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Abstract. The brain tissue segmentation on MR images is valuable to quantifying the brain structures to evaluate the diagnosis, progression and treatment in different neurologic diseases. The medical image data is volumetric with three axis plane: axial, coronal and sagittal planes. Some existing deep models tackle this issue using 3D convolutional architecture, however, the differences in the spatial information in each axis plane has not been fully exploited. Also, the MRI data volume is usually has various modality with different imaging parameters, providing rich diagnostic information. In this work, we proposed a 3D spatial weighted U-shape fully convolutional network (3D-SW-UNet) for brain tissue segmentation on multi-modality MR images. In the architecture, we design a volumetric feature recalibration layer (VFR layer) based on the spatial information in each axis plane to weigh the features. We also extend the VFR layer to the multi-modality MRI setting. To fully train the shallow layers, we introduce the deep supervision strategy to help the flow of supervision information in the network. Ablation studies shows the effectiveness of the VFR layer and the deep supervision training strategy. Here a weighted cross entropy loss function is proposed for optimization which leads to a better segmentation accuracy.

Keywords: Brain Tissue Segmentation · Convolutional Neural Network · Multi-modality MRI · Spatial Weighting.