StrokeNet: 3D Local Refinement Network for Ischemic Stroke Lesion Segmentation

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Abstract. We present a StrokeNet - an efficient yet conceptually simple 3D residual framework for automatic ischemic stroke lesion segmentation. Our model is able to directly predict dense voxel segmentation of stroke regions in 3D brain CT scans. The contributions of this report are three-fold: (i) we propose a novel multi-level 3D refinement module that automatically aggregates both local details and spatial-temporal context information within 3D convolutional layers, leading to clear performance boost; (ii) we incorporate recent Focal loss into our framework, enabling our model to naturally cope with data imbalance that previously attempted in dense training and sampling; (iii) a new training strategy is introduced by leveraging curriculum learning, where we design the curriculum by incorporating data augmentation and the Focal loss. These technical developments are integrated seamlessly into a single 3D segmentation model, resulting in a highly-compacted and end-to-end trainable model that can run at about 0.5s per MRIs - about 50 times faster than previous approaches. The proposed StrokeNet is evaluated on Ischemic Stroke Lesion Segmentation (ISLES) Challenge 2018, where we report preliminary results on the training set.

Methods. We present a new StrokeNet which is a 3D segmentation network built on deep residual architecture. Our model is able to directly outputs dense voxel-level segmentation results of stroke or non-stroke regions from 3D brain CT scans, *without any post-processing*. First, we propose a new 3D refinement module capable of aggregating rich fine-scale spatio-temporal features over multiple 3D convolutional layers. This allows it to explore both local detailed features and high-level context information in both spatial and temporal domain, which is critically important to achieving accurate segmentation. Second, we introduce a new training strategy that incorporates curriculum learning and recent Focal loss into our 3D segmentation networks. This allows our model to learn more efficiently with the designed curriculum, where the issue of dense training and class imbalance are handled effectively and naturally. Third, we integrate these technical improvements into a single model which allows for a direct prediction of dense voxel-level segmentation in a single shot. This results in a highly efficient model running at about 0.5s per MRIs - allowing for real-world application of StrokeNet.

Results. StrokeNet was evaluated on the training set of ISLES Challenge 2018. We report preliminary results by computing mean values over 5-fold cross-validations on the training set. StrokeNet obtains a mean *Dice* score of 52.26%, with a recall and a precision of 55.50% and 58.84%, respectively.