Brain Structure Segmentation Using Multi-Modality Imaging and Dilated Residual Networks

Hongwei Li[†], Andrii Zhygallo[†] and Bjoern Menze[†]

[†] Technical University of Munich
{hongwei.li, andrii.zhygallo, bjoern.menze}@tum.de

1 Data Preprocessing

Data preprocessing includes the following two steps.

Data normalization A patient-wise normalization of the image intensities was performed both during training and testing. For the scan of each patient, the mean value and standard deviation were calculated based on intensities of all voxels. Then each image volume was normalized to zero mean and unit standard deviation.

Data augmentation Rotation, shearing, scaling along horizontal direction (x-scaling), and scaling along vertical direction (y-scaling) were employed for data augmentation on the 7 cases with full annotations. After data augmentation, a four times larger training dataset was obtained.

2 Methodology

2.1 Input modalities

We employ multi-sequence data including T1-weighted (T1), T1-weighted inversion recovery (T1-IR) and FLAIR which captures complementary information of brain structure. These modalities were combined as a three-channel input of the deep networks.

2.2 2-D image segmentation using dilated residual networks

We employed Dilated Residual U-Net (DRUNet), which was originally proposed in [1] for nerve head tissues segmentation in optical coherence tomography images. DRUNET exploits the inherent advantages of the U-Net skip connections [3], residual learning [2] and dilated convolutions [4] to capture rich context information and offer a robust brain structure segmentation with a minimal number of trainable parameters.

2.3 Ensemble model

To improve the robustness of our model, an ensemble method was employed for the final segmentation. Five DRUNet models with the same architecture were trained with shuffled batches. Then when given a new testing subject, each subject will be segmented based on the averaged probability maps generated by the five DRUNets.

References

1. Devalla, S.K., Renukanand, P.K., Sreedhar, B.K., Perera, S., Mari, J.M., Chin, K.S., Tun, T.A., Strouthidis, N.G., Aung, T., Thiery, A.H., et al.: Drunet: A dilated-residual u-net deep learning network to digitally stain optic nerve head tissues in optical coherence tomography images. arXiv preprint arXiv:1803.00232 (2018)
2. He, K., Zhang, X., Ren, S., Sun, J.: Deep residual learning for image recognition. In: Proceedings of the IEEE conference on computer vision and pattern recognition. pp. 770–778 (2016)
3. Ronneberger, O., P.Fischer, Brox, T.: U-net: Convolutional networks for biomedical image segmentation. In: Medical Image Computing and Computer-Assisted Intervention (MICCAI). LNCS, vol. 9351, pp. 234–241. Springer (2015), http://lmb.informatik.uni-freiburg.de/Publications/2015/RFB15a, (available on arXiv:1505.04597 [cs.CV])
4. Yu, F., Koltun, V.: Multi-scale context aggregation by dilated convolutions. arXiv preprint arXiv:1511.07122 (2015)