Domain Generalization for White Matter Hyperintensities Via Mixup and Adversarial Learning on Lower Layers

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1 Data and preprocessing

Our training set consists of three datasets from Utrecht, Singapore and AmsterdamGE3T. To train our model, we use both FLAIR and T1, and preprocess training images by using Gaussian Normalization on the voxel intensity of training images and test images after masking the brain. We then remove first and last few slices of brain of each subject to ignore unimportant information. Moreover, we cropped and padded each slices to 200 x 200 to input to our model.

2 Methods

We use a domain adversarial approach to train a segmentation network to obtain good performance on the unseen data(target domains). Notably, we assume absolutely no access to target domains. Our model illustrated in Fig.1. consists of the commonly used U-Net[2](segmentor) and a convolutional Domain Adversarial Nerual Network[1](CDANN) originally proposed by Ganin et al. The segmentor predicts the segmentation on the input images, and the CDANN classifies domains on the features extracted from lower layers of the segmentor. To achieve adversarial learning, we connect these two networks by a gradient reversal layer. To further reduce the discrepancy across different domains, we extended Mixup[3] to do convex combination of not only the inputs and segmentation labels but also domain labels to augment the training data. Our proposed method can let the segmentor learn the domain-invariant features and well generalize to unseen domains.

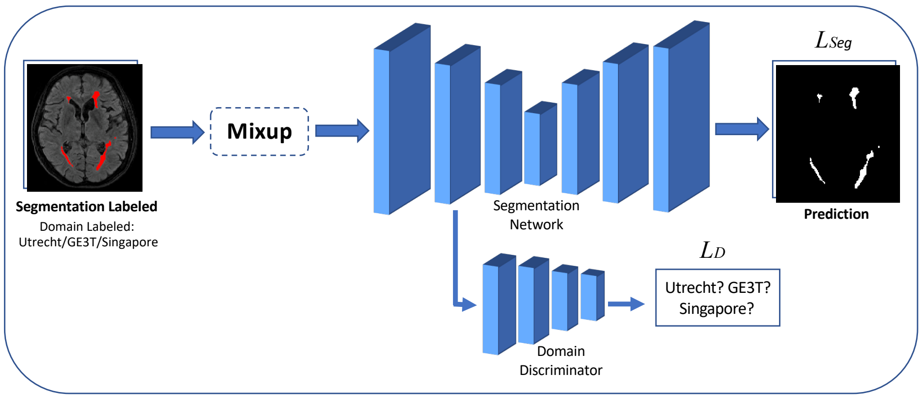

Fig. 1. Illustration of the proposed model which consists of a segmentation network and a domain discriminator

2.1 Data Augmentation

We randomly augment each training slice by scaling[0.9%,1.1%], rotation[-15°,15°] and shearing[-18°,18°].

2.2 Data Postprocessing

We applied a 0.5 threshold to the predicted segmentation and recover the prediction from 200 X 200 to the original sizes.

References

1. Y. Ganin and V. Lempitsky. Unsupervised domain adaptation by backpropagation, 2014.
2. O. Ronneberger, P. Fischer, and T. Brox. U-net: Convolutional networks for biomedical image segmentation, 2015.
3. H. Zhang, M. Cisse, Y. N. Dauphin, and D. Lopez-Paz. mixup: Beyond empirical risk minimization, 2017.