Combination of CNN and Hand-crafted feature for Ischemic Stroke Lesion Segmentation

Haocheng Shen[1], Siyamalan Manivannan[1], Roberto Annunziata[1], Ruixuan Wang[1], and Jianguo Zhang[1]

CVIP, Computing at School of Science and Engineering, University of Dundee, UK

1 Motivation

CNN can automatically learn discriminative local features and give superior performance than hand-crafted features in various applications such as image classification, semantic segmentation and object detection. CNN has also been applied to MRI brain image analysis and achieved state-of-the-art results for brain tumor region segmentation [3, 4], stroke lesion segmentation [4], and mircobleeds detection [2]. Recently, some studies (e.g. [5]) show that hand-crafted features may provide complementary information with CNN, hence combining them with the features extracted from CNN may give improved performance than only using the features from CNN. Motived by this, we formulate the segmentation of ischemic stroke lesion in acute MRI scans as a pixel-level classification using a combination of CNN and hand-crafted features.

2 CNN Architecture

We used a CNN architecture which is similar to [1]. It is a fully convolutional neural network containing a downsampling path and three upsampling paths. In the task of stroke lesion segmentation, there is a large variation on the size, location and shape of lesions. Therefore, encoding information at multiple scales is necessary and preferable than considering information at only one level. The downsampling path is able to extract the abstract information with high-level semantic meaning, while the three upsampling paths are designed to capture the fine details. These three upsampled feature maps are then combined at the later stages of the CNN architecture so that the classification layer fully make use of the information appears at multiple scales [1].

3 Hand-crafted Feature

We use the following hand-crafted features:

- intensity;
- the hemispheric intensity difference between two symmetric pixels in the axial view;
- first order statistics in a $w \times w$ volume patch;
- maximum response filter (MR8) [6].

At each 2D pixel location, these local features are extracted independently from each image modality and combined together to get a feature representation for that pixel.

4 Patient-specific Classifier

As there is a large variation of lesions in the dataset, it will be beneficial to train a pool of binary classifiers instead of one. Each binary classifier in this pool is designed to separate the positive (lesion) features extracted from a patient from all the negative (normal) features extracted from the same patient. In this way we believe that some rarely appeared lesions can be easily discriminated from the normal tissue compared to a binary lesion classifier which is trained using all the training data (without using patient information). In the testing time a voting strategy (averaging the top 3 probabilities obtained by the binary classifiers in the pool) is used to get the prediction of an input.

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