Ischemic stroke lesion segmentation using CNN based method

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Abstract. In this paper an automatic ischemic stroke lesion segmentation method based on Convolutional Neural Networks (CNN) is presented. Proposition of the method is motivated by the success of multi-path CNN approaches [1]-[2]. Segmentation model architecture is composed of three CNNs. One CNN is extracting features from the patches covering large region, other one from the medium sized patches and the last one is extracting local features. Each CNN's input is composed of the sub-images extracted from the slices of apparent diffusion coefficients (ADC) map and from five perfusion maps, namely cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT), time to peak concentration of the contrast agent (TTP) and time to maximum (TTM). Volume pre-processing is composed of mean-std normalization and alignment using affine transformation. In addition to the information extracted from the appearance differences between healthy brain tissue and stroke lesion, the model exploits brain's asymmetry caused by lesions, that is very often noticeable. In order to achieve this, for large and medium region CNNs, in addition to the patches taken from six modalities, their corresponding pairs at the position mirrored with respect to the sagittal plane are extracted. With the purpose of incorporating spatial information, large region CNN input includes relative distances to the brain center for each pixel of a patch. The purpose of local region CNN is segmentation refinement. Features extracted by CNNs are concatenated and classified using a fully connected network. In order to address segmentation difficulties in lesion proximity, the loss function is represented as a linear combination of log-losses corresponding to two classification problems. The first one considers entire brain region and the other one only lesion and its proximity. Segmentation post-processing is based on connected component analysis.

References

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