Automatic Early Ischemic Changes Detection Using Convolutional Neural Networks in Patients with Acute Ischemic Stroke

Stroke is the second most common cause of death worldwide. About 80% of strokes are caused by focal cerebral ischemia [1]. The rapid administration of intravenous recombinant tissue-type plasminogen activator to appropriate patients is one of the main treatments for acute ischemic stroke. A fast restoration of blood flow in ischemic stroke patients has a huge effect in reducing long-term morbidity [2]. The Alberta Stroke Program Early CT Score (ASPECTS) is a 10-point CT scan score designed to quantify early ischemic changes in patients with acute ischemic stroke [3]. This simple and reliable score is used to predict functional outcome, risk of hemorrhage and to facilitate treatment selection [4], [5] and [6].

The score divides the MCA territory into 10 regions of interest (Figure 1) and therefore 10 points are allocated for the MCA territory. For each region presenting focal swelling or parenchymal hypoattenuation 1 point is subtracted from the score. Thus, a normal scan should receive an ASPECTS score of 10, while a score less than or equal to 7 indicates worse functional outcome. Patients with ASPECTS score above 6 are good candidates for thrombectomy. A score of zero indicates diffuse ischemic involvement throughout the MCA territory [4].

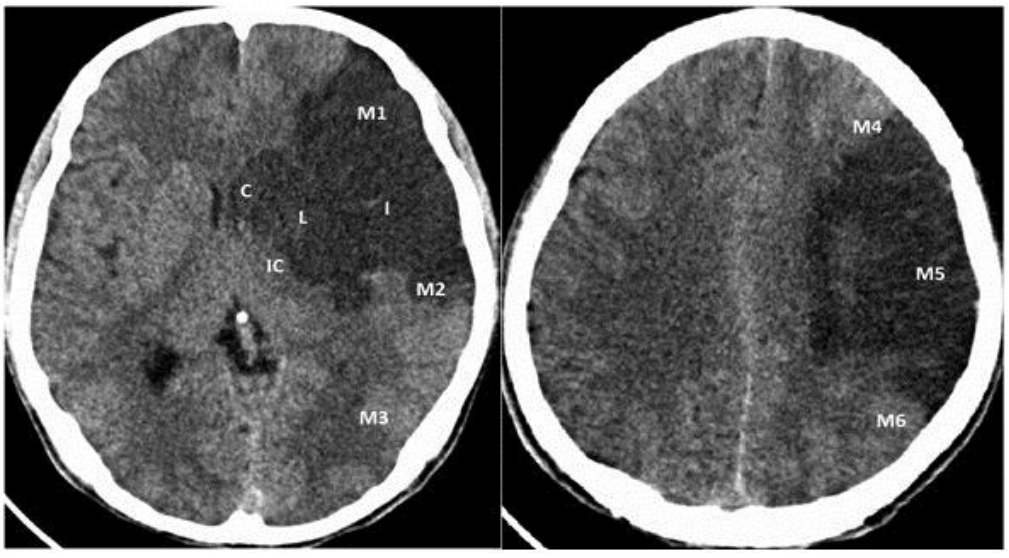

Figure 1 - Aspects Score Regions of Interest

However, the assessment of early ischemic changes requires training, is time consuming and may be prone to errors (false-positives) [4]. The prognosis value of the ASPECTS score and treatment are both time dependent. Therefore, a faster and more

accurate automatic estimation of ASPECTS score can have a huge impact in patient outcome.

Recently, in the field of Deep Learning, the Convolutional Neural Networks (CNNs) have shown state-of-the-art results regarding image classification and segmentation. These networks are composed of layers capable of learning representations of data with multiple levels of abstractions. An important aspect of deep learning is that the features that compose these layers are learned from data, and dot not need to be designed by a human. Therefore, deep learning approaches can save time and effort by extracting features by themselves. CNNs have shown great potential for medical applications like brain tumor segmentation [7], liver tumor segmentation [8], pancreas segmentation [9] and in a computer-aided diagnosis applications [10].

As a member of the Biomedical Engineering department you will have the opportunity to work with the automatic quantification of the ASPECTS score using Convolutional Neural Networks and CT scan images for predicting patient outcome. Previous programming knowledge is required.

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