Thesis subject, University of Strasbourg: Connected operators, hierarchical representations and deep learning

Advisers and laboratory

— Chief adviser : Benoît Naegel - IMAGeS team - ICube - b.naegel@unistra.fr
— Adjunct adviser : Adrien Krähenbühl - IMAGeS team - ICube - krahenbuhl@unistra.fr

Subject

In the field of mathematical morphology, connected operators are filters that enable to simplify an image while preserving its contours. These operators are usually based on hierarchical structures gathering the level lines or level sets of the image. Based on this concept, several hierarchical representations have been developed : max-tree, binary partition tree, tree of shapes. These structures have been used in various applications : image filtering, image simplification, image segmentation and object recognition. In the mean time, in the field of semantic segmentation, deep learning is booming. In the field of image analysis, these techniques are generally based on convolutional neural networks. The objective of this thesis is to rely on the representational power of hierarchical structures to guide and improve learning in the case of convolutional neural networks. To this aim different paths will be explored :

— use hierarchical representations as input for the neural network. The regions of this hierarchy could be classified independantly and the results merged in order to obtain a dense (pixel-based) classification
— use connected operators to preprocess the images in order to improve the classification
— hierarchical representations enable to simplify an image by the mean of attribute filters (such as area opening, contrast opening). Such filters could be involved inside the neural network as non-linear operators, in replacement or complement of convolution operators. A problematic in this case is related to the gradient computation for the optimisation. To this aim, an alternative definition of these operators could be considered.

These methods will be evaluated and compared to other methods in the field of biomedical images segmentation.

Références

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