Subject: Robust graph-based deep learning; application to (bio)medical image analysis

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Abstract (up to 10 lines):

Numerous deep learning (DL) approaches have been proposed for image analysis tasks in computer-aided (bio)medical applications. Images are generally considered as examples that are learned directly to the system, then able to predict specific decisions (e.g. image segmentation or classification). Nevertheless, image data can be preferably represented with discrete structures as graphs. This PhD deals with the development of novel DL methods based on graphs, by robust approaches, i.e. they are able to resist to inherent image data noise. Within a multidisciplinary team, composed of scientific members and medical doctors, several applications can be considered, mostly related to the 3D reconstruction of vascular networks.

Skills: Good mathematical background; solid skills in programming; good knowledge of machine/deep learning and image analysis/processing preferable; experience in medical or biomedical applications appreciated

Keywords: Deep learning; Graphs; Robustness; Image analysis; Biomedical and medical applications
An extremely common methodology for analyzing image data today in computer-aided (bio)medical applications is the development of deep neural networks and other related deep learning (DL) architectures [1]. These networks generally take directly images as inputs during learning phase, and are then able to predict specific decisions (e.g. image segmentation or classification) with new image samples. Recently, a relevant work has been done towards generalizing DL to graphs [2,3]. Considering graphs is an important task with many potential applications, such as analyzing data on networks, computer vision, natural language processing, medical applications, etc. Additionally, image data can be preferably represented with discrete structures as graphs. As an illustration of the interest in learning graphs by neural structures, we can note that 2 libraries, named NSL (Neural Structured Learning) and Deep Graph Library, have been developed for this purpose, based on the reputed Tensor Flow framework [4,5].

This PhD deals with the development of novel DL methods based on graphs, by robust approaches, i.e. they are able to resist to inherent image data noise [6]. We would like to investigate further Graph Convolutional Networks (GCN) [2] and their application to 3D vascular segmentation and reconstruction, which is a very recent concern [7,8]. It is even possible to combine GCN and standard Convolutional Neural Networks (CNN) to learn and represent both structural and image intensity information into a single DL framework.

The PhD candidate will join the CaVITI multidisciplinary team (Cardio-Vascular Interventional Therapy and Imaging), hosted at Le Puy-en-Velay. It is composed of scientific members (skilled in computer science, signal/image processing, machine learning, etc.) and medical doctors (specialized in interventional radiology, hepatology, liver surgery, etc.) from University Hospital (CHU) of Clermont-Ferrand. This PhD will be associated to ongoing research projects coordinated by the host team, in particular the ANR R-Vessel-X [9] and PHC/Polonium DeepVesselNets projects. Main applications would be the 3D reconstruction of liver vessels from MRI (Magnetic Resonance Imaging) sequences or from microscopic imaging of small animals (synchrotron acquisitions or µMRI), but the methodologies developed in this PhD could be applied to other organs, e.g. brain vasculature or lung airwaves.
References (up to ½ page):


How to candidate?
Contact the supervisor