Post-Doc Position at LRCS (Amiens, France)

Semantic Segmentation of X-ray Computed Tomography images using Convolutional Neural Network

Laboratory: LRCS (https://www.lrcs.u-picardie.fr/en/)

Scientifics collaborators: Dr. A. Demotière (CNRS Scientist) + Zeliang Su (PhD Student)

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Duration: one-year position funded by Hauts-de-France region

Date: starts in March 2020

Skills for the candidate: Python coding, Machine/Deep learning, CNN, Image processing

Prerequisites: strong record with published papers

Salary: €2.300

To send your resume/cover letter or any enquiries, please contact arnaud.demortiere@u-picardie.fr

Research topic: X-ray nano Computed Tomography (CT) with a spatial resolution of 20-60 nm is a strong new tool to probe Li-ion battery materials in a non-destructive mode [1]. Nano CT allows us to distinguish in 3D different phases of composite electrode such active particle, carbon-binder (CBD) and porosity, which is crucial to properly get insight into electrochemical properties of Li-ion battery. 3D morphological parameters, such as porosity, tortuosity, connectivity, specific surface and surface contact, directly drive ion diffusions and electronic conductivity as well as electrochemical reactions. Furthermore, the coupling between absorption and phase contrast modes (in X-ray imaging) is always required to identify each phase containing heavy and light elements. Tomography reconstruction steps have to be then optimized as so to minimize artifacts and noise as well as get high contrast. Tomopy, an open-source Python package developed by ID32 beamline from APS synchrotron (Argonne NL, USA), is used for tomographic data processing and image reconstruction: rotation center determination, phase retrieval, tomogram reconstruction (via CPU or GPU) [2].

Complexity of these composite features as well as presence of multiple phases demands careful segmentation to get usable data for 3D analysis. Machine learning [3] provides a robust solution to automate segmentation processes by learning from existing model data relationships and is suitable to analyze of high-dimensional complex data problems. Its implementation in this field can make segmentation almost an entirely automated process. Among different approaches, convolutional neural network (CNN) [4] is a popular deep learning technique for image processing. It is capable of classifying structural features in image like the way the human visual system operates. Its accuracy and efficiency for feature recognition and classification have been proved for various applications. Different hierarchical levels of the trained network are used to identify features of varying complexity. The trained network is then used to segment the entire 3D image stack.

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Figure 1: Schematic showing workflow of the segmentation process on TXM datasets using a deep learning (Convolutional Neural Network) approach [4].

3D tomographic reconstructions will be performed using Tomopy library. Subsequent 3D segmentation, quantification and visualization will be carried out using a Python toolbox named Xlearn [5], which was used to implement the CNN model. Xlearn tool is currently improved by using TensorFlow platform instead Keras one and by optimizing of several methods/parameters such as batch normalization, activation functions, dimension and number of kernel as well as neural architecture (U-Net/Seg-Net). The CNN approach is currently applied on a stack of 2D images, the use of complete 3D objects will be developed for 3D segmentation. The influence of ground truth data will be furthermore evaluated in the image processing. A development around the evaluation of segmentation errors will be also planned by using different approaches and quantify their impacts on morphological key parameters in 3D objects of battery electrode materials.

References: