平成28年度 情報工学コース卒業研究報告要旨

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卒業研究題目	Study on Unsupervised Segmentation of 3D Medical Images based on Clustering and Representation Learning	

This thesis studies the unsupervised segmentation of 3D medical images based on clustering and representation learning. Recently, deep neural networks have brought significant advances in machine learning and computer vision. This is because they can automatically discover feature representations required for detection or classification. Meanwhile, the amount of 3D medical images from different modalities has been continuously growing. Various essential tasks for the analysis of medical images need assistance of computer vision technology. However, a number of recent methods relies on supervised learning requiring large amounts of manually annotated data. Manual labeling of 3D medical image data can be very time-consuming, expensive and error-prone. Moreover, medical expert knowledge is often required. Thus, research into unsupervised learning, especially for 3D medical images, is a promising direction.

In this thesis, we propose a unified approach to unsupervised deep representation learning and clustering for medical image segmentation. Our method consists of two phases. In the first phase, we learn deep feature representations of training patches from a target image using Joint Unsupervised LEarning (JULE). JULE is a state-of-the-art method of unsupervised representation learning and clustering. JULE iterates two steps: (1) clustering image representations generated by a Convolutional Neural Network (CNN); (2) updating the CNN parameters using cluster labels as supervisory signals. By repeating these steps, we obtain a trained CNN which could output discriminative representations. In the second phase, we assign labels to the deep representations from the CNN using conventional K-means. We then project these labels to the target image in order to obtain a segmentation. By combination of these two phases, we can reduce the total processing time and save computational resources compared to using JULE alone. we also present a simpler segmentation method using spherical K-means, which is a non-deep representation learning and clustering method.

We evaluate our methods on three images of lung cancer scanned with a micro-computed tomography (micro-CT) scanner. We aim to divide each image into the regions of invasive carcinoma, non-invasive carcinoma, and normal tissue. These images are selected by the reason that segmenting the regions on micro-CT images based on histopathological features could contribute to the future pathological examination. For evaluating segmentation results, we use a standard metric for clustering, Normalized Mutual Information (NMI). Our experiments show the main method outperforms the simpler method both quantitatively and qualitatively. Figure 1 shows one example of our results.

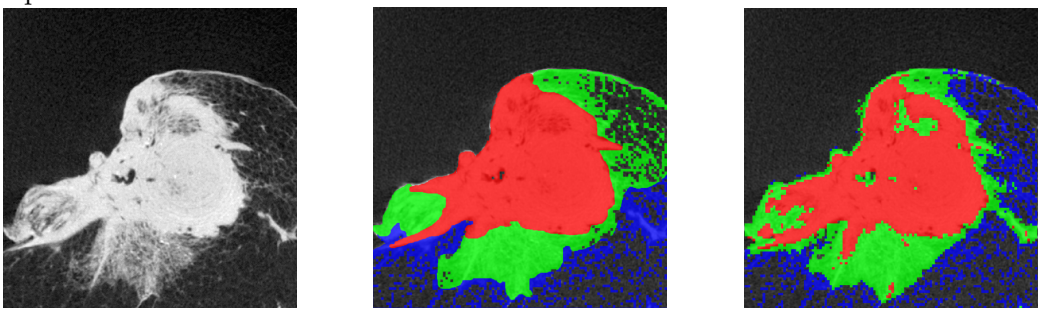

Figure 1: Left: original image. Center: ground truth. Right: our segmentation result.