AbstractID: 14501 Title: Machine Learning for Medical Image Processing and Pattern Recognition

Kenji Suzuki, Ph.D.
Department of Radiology
University of Chicago

Machine learning plays an essential role in medical image analysis, because objects such as lesions and organs in medical images cannot be modeled accurately by simple equations; thus, tasks in medical image analysis require essentially "learning from examples." One of the most popular uses of machine learning in medical image analysis is the classification of objects such as lesions into certain categories (e.g., abnormal or normal, lesions or non-lesions). This class of machine leaning uses features (e.g., diameter, contrast, and circularity) extracted from segmented objects as information for classifying the objects. Machine learning techniques in this class include linear discriminant analysis, a k-nearest neighbor classifier, an artificial neural network, and a support vector machine.

Recently, as available computational power increased dramatically, a new class of machine learning called pixel/voxel-based machine learning emerged in medical image processing and analysis, which uses pixel/voxel values in images directly instead of calculated features as input information; thus, feature calculation is not required. Because pixel/voxel-based machine learning can avoid errors caused by inaccurate segmentation and feature calculation, the performance of the pixel/voxel-based machine learning can be better than common feature-based machine learning. Such advanced machine-learning techniques in this class include neural filters, neural edge enhancers, massive-training artificial neural networks, convolution neural networks, and shift-invariant neural networks.

This lecture will provide an overview of techniques, methodologies, and applications of machine learning used in medical image processing and pattern recognition, which have been developed and advanced mainly in the field of diagnostic radiology in the past two decades or so. The applications of these machine-learning techniques include quantum noise reduction, enhancement of the boundary of an organ, lesion enhancement, classification of lesions, and computer-aided diagnosis. Once we have learned such machine-learning techniques and methodologies, they can be translated quickly into new techniques for solution of problems in radiation therapy.

Learning Objectives:

1. Understand the basic principle of machine-learning techniques

2. Learn various techniques in the two major classes of feature-based and pixel/voxel-based machine learning

3. Understand the advantages and limitations of machine-learning techniques

4. Learn applications of machine-learning techniques in medical image processing and pattern recognition

5. Consider applications of machine-learning techniques and methodologies in the field of radiation therapy