The rapid development of digital radiographic detectors in recent years has the potential to drive many film-based x-ray imaging procedures into the digital domain in the near future. The availability of images directly acquired by digital detectors will facilitate the implementation of digital image processing and computer-aided diagnosis (CAD) algorithms to assist radiologists in image interpretation.

The fields of image processing and computer vision are very broad and well established in industrial and military applications. In medical imaging, image enhancement is used more conservatively if the images are to be viewed by radiologists because strong enhancement often introduces artifacts that may lead to false diagnosis. For example, in digital radiography, image processing often aims at matching the appearance of the displayed image to conventional screen-film images with only moderate enhancement. Unsharp masking is the most commonly used filter on digital radiographic images. Various image processing techniques have been developed for applications such as contrast enhancement, noise suppression, image reconstruction, and image registration in different digital imaging modalities.

CAD is one of the promising approaches that is expected to improve the diagnostic accuracy of radiologists' interpretation of medical images. A CAD algorithm is generally a combination of many image processing techniques which are specifically designed for enhancement, segmentation, feature extraction, and classification of a given type of lesion. CAD algorithms can be developed to automatically detect suspicious lesions on radiographs and to alert the radiologists to these regions. Other algorithms can extract image features of a suspicious lesion, which may be used alone or in combination with other diagnostic information, and estimate its likelihood of malignancy by using a trained classifier. The computer-extracted features may include morphological features that are commonly used by radiologists for diagnosis, as well as texture features that may not be readily perceived by human eyes. The computerized analysis may therefore provide additional information to assist radiologists in the detection and diagnosis processes.

Classifier design is one of the key steps in the development of CAD algorithms. A classifier is required for differentiating true and false signals in a detection task and for distinguishing malignant and benign lesions in a classification task. Two of the most commonly used classifiers in CAD algorithms are artificial neural networks and linear discriminants. Classifier design depends on the availability of training samples. It is

known that the generalizability of a trained classifier depends strongly on the size of the design sample set. The complexity of the classifier and the dimensionality of the feature space also affect the sample size requirement.

In this course, we will discuss image processing techniques that may be useful for processing of radiographic images. Artificial neural networks for different CAD applications will be described. The effects of sample size on classifier design will be examined. Understanding these techniques and issues is expected to improve the utilization of diagnostic information from digital radiographic images.

Learning Objectives:

To learn some common image processing techniques, neural networks and linear discriminant analysis, and to understand some issues involved in classifier design