This dissertation explores learning algorithms that can be used to extract imaging markers reliably so that obesity-cancer relationship can be studied. In the first part of this dissertation, we detect white adipose tissue (WAT) and its two subtypes from CT scans: Visceral Adipose Tissue (VAT) and Subcutaneous Adipose Tissue (SAT).

In the second section of the dissertation, we automatically detect, segment, and quantify brown adipose tissue (BAT) using PET scans because unlike WAT, BAT is metabolically active. After identifying BAT regions using PET, we perform a co-segmentation procedure utilizing asymmetric complementary information from PET and CT. Finally, we present a new probabilistic distance metric for differentiating BAT from non-BAT regions.

In the third part, we propose different supervised strategies for the characterization of lung nodules and Intraductal Papillary Mucinous Neoplasms (IPMN). We propose a new end-to-end trainable multi-view deep Convolutional Neural Network (CNN) for nodule characterization. The trained network is used to extract features from the input image followed by a Gaussian Process (GP) regression. We next propose a 3D Convolutional Neural Network based nodule characterization strategy. We acquire the task dependent feature representation for six high-level nodule attributes and fuse this complementary information via a Multi-task learning (MTL) framework. For the diagnosis of IPMN, we propose a CNN based computer aided diagnosis (CAD) system by utilizing multi-modal MRI scans.

Finally, we propose an unsupervised learning strategy for the diagnosis of lung nodules and IPMN. Since the task of annotating medical images is laborious and time-consuming, we explore the potential of unsupervised learning approaches. First, we perform clustering on the appearance features obtained from the images to estimate an initial set of labels. We then compute label proportions corresponding to each cluster. We finally train a proportion-SVM classifier using the label proportions and clusters to obtain the final classification.