

Abstract

Whole slide imaging (WSI) is an emerging imaging technology that has the potential to revolutionize the field of digital pathology, but its acceptance in computer-aided diagnostics is hindered by a relative scarcity of labeled data sets compared to those obtained using traditional imaging technologies. Exhaustive manual labeling and annotation are significantly time-consuming due to the sheer size of the images, and require technical expertise not readily available among the general population. The use of artificial intelligence for such tasks, on the other hand, suffers from low confidence in results and a lack of transparency as perceived by the medical community.

To alleviate these problems, this work presents an unsupervised segmentation algorithm which draws on sparse representation theory and cluster analysis to provide annotations with greater algorithmic transparency than traditional neural networks. The algorithm learns a sparse dictionary representation for all overlapping patches in an image and partitions the dictionary into multiple sub-dictionaries based on atom utilization correlations, allowing one to see exactly what features the algorithm is searching for in the segmentation process. The extracted image patches are then reconstructed using each sub-dictionary individually and classified per the best-performing dictionary, with performance gauged by a weighted sparsity and reconstruction error metric. The algorithm's functionality is demonstrated by application to glomerulus regions extracted from pre-annotated mouse kidney whole slide images and compared to results obtained through traditional neural network segmentation techniques.