Locality Sensitive Deep Learning for Detection and Classification of Nuclei in Routine Colon Cancer Histology Images

Detection and classification of cell nuclei in histopathology images of cancerous tissue stained with the standard hematoxylin and eosin stain is a challenging task due to cellular heterogeneity. Deep learning approaches have been shown to produce encouraging results on histopathology images in various studies. In this paper, we propose a Spatially Constrained Convolutional Neural Network (SC-CNN) to perform nucleus detection. SC-CNN regresses the likelihood of a pixel being the center of a nucleus, where high probability values are spatially constrained to locate in the vicinity of the centers of nuclei. For classification of nuclei, we propose a novel Neighboring Ensemble Predictor (NEP) coupled with CNN to more accurately predict the class label of detected cell nuclei. The proposed approaches for detection and classification do not require segmentation of cell nuclei. We have evaluated them on a large dataset of colorectal adenocarcinoma images, consisting of more than 20,000 annotated nuclei belonging to four different classes. Our results show that the joint detection and classification of the proposed SC-CNN and NEP produces the highest average F1 score as compared to other recently published approaches. Prospectively, the proposed methods could offer benefit to pathology practice in terms of quantitative analysis of tissue constituents in whole-slide images, and potentially lead to a better understanding of cancer.