A Novel Method for Cancer Whole Slide Image Processing Utilizing a Multi-Scale Convolutional Residual Neural Network for Regression

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Cancer remains a leading cause of death worldwide, with approximately 10 million fatalities annually. Whole Slide Imaging (WSI) and Deep Learning can enhance histopathological analysis, enabling faster and more accurate diagnoses. This research presents a Multi-Scale Convolutional Residual Neural Network for Regression (MSCRNN-R) to quantify malignant cells in WSI. Unlike binary classification, it provides numerical tumor quantification through dynamically generated heatmaps. The methodology involves preprocessing WSIs derived from a public dataset from The Cancer Imaging Archive (TCIA) using H&E stain normalization, tiling into 256×256 patches and grayscale conversion, followed by training a deep learning model with global pooling and residual connections, the model is then used for the generation of a heatmap regarding cancer percentage of the overall WSI. The proposed model achieves remarkable efficiency, with an average inference time of at maximum 15.3ms, surpassing segmentation-based approaches like U-Net, U-Lite, and U-NeXt, which inference times surpass 24ms. The model exhibits a margin of error of 6.8% in correctly processed cases and 8.16% with outliers, confirming its reliability. Additionally, this study validates prior findings on Artificial Neural Networks (ANNs) in tumor detection, particularly supporting Sambyal and Sarwar (2023) in regards to the possibility of using ANNs to analyze WSIs. Future work includes improving precision with enhanced computational resources and extending the methodology to other applications, such as Natural Killer cell quantification. These findings demonstrate the potential of regression-based models to provide faster, scalable, easily portable and clinically viable solutions for computational pathology.

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