Can we train a single deep learning model to detect and segment nuclei images acquired with any microscope or staining modality?

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Human body comprises around 30 trillion cells each containing nucleus full of DNA that are studied regularly for research in drug discovery, understanding body functionality, etc. Lack of automated and reliable segmentation of the cell nuclei is one the major bottleneck in reaching the potential speed of growth in these fields of science. Over the years many algorithms been proposed for nuclei segmentation [1], however most of them perform well only for specific cell, staining or imaging type [2]. In this work, we developed a framework with deep learning methods that can accumulate knowledge about nuclei from expert biologists through annotations and convert it into a tool for nuclei segmentation. In the presented work, we first trained an Inception-resnetV2 [2] network with Faster R-CNN detection framework to initially detect the nucleus in terms of bounding box. In the second part, we trained a segmentation network with VGG16 architecture to segment the nucleus within the bounding box. The first stage was trained on 670 images and the second stage was trained on 32000 nuclei. On the test sets of 65 images, we recorded .5 mean average precision (map), when averaged over 0.5 to 0.95 (with 0.05 interval) intersection by overlap (IoU) ratio of segmentation with ground truth. Figure 1 illustrates the nuclei segmentation results on some of the challenging examples in the test set. The resulted accuracy shows the model is able to learn about the required visual properties for identifying nuclei and execute it on unseen images with reliable accuracy.

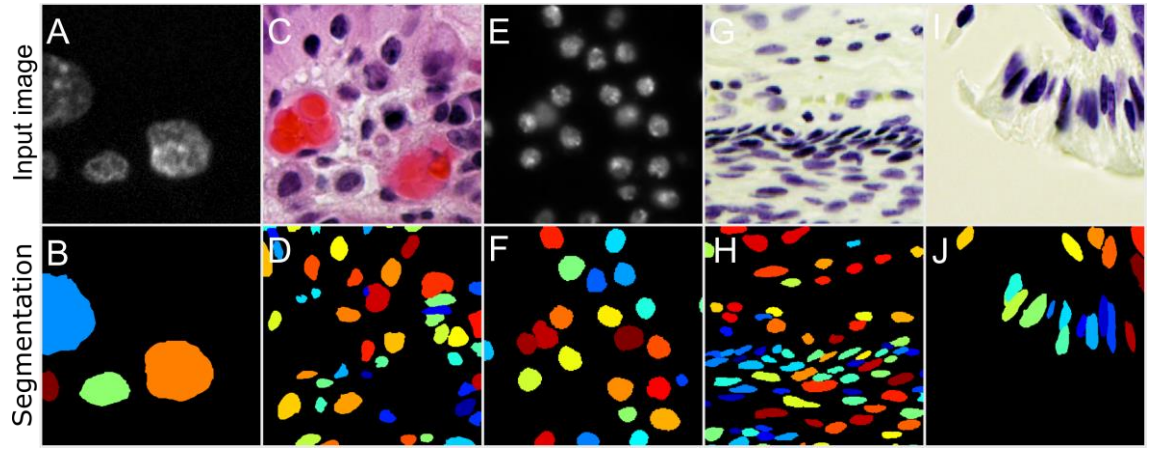

Figure 1: Nuclei segmentation result on input images of varies imaging modalities A, C. E, G & I are illustrated (with jet color map) in B, D, F, H & J respectively.

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