Project Deliverable Template

First & Last Name
Student Number, email
Link to Google Colab

Introduction

Quantitative bioimage analysis relies heavily on accurate identification of cells and nuclei in microscopy images. Reliable and accurate cell segmentation provides measurements such as cell counts, density, and morphology statistics, which are routinely used, to compare experimental conditions in biomedical research and support tissue quantification in clinics. In practice, the technology often bottlenecks: manual outlining is time-consuming and unreliable, while conventional image processing techniques can be brittle when images vary in staining, illumination, focus, or when the nuclei or cell borders overlap.

This project aims to develop a segmentation and counting model that takes microscopy images as input, and outputs **traced cell boundaries and cell counts**. The core model will be a convolutional segmentation neural network trained on annotated data with evaluation emphasizing both pixel segmentation quality and object level correctness. Figure 1 shows sample inputs and outputs of the target model.

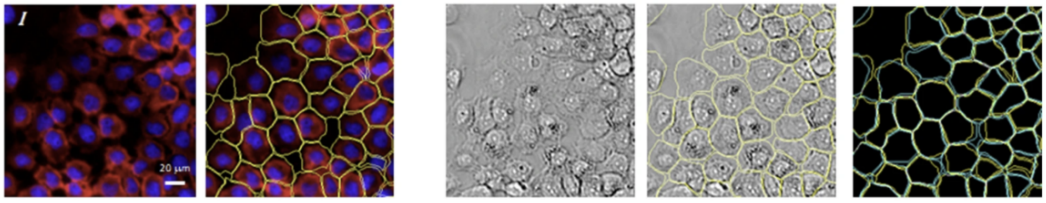

Figure 1: Left: cell image & tracing under a electron microscope, **Right:** same, but under a light microscope.[1]

Deep learning is particularly well-suited to this task because nuclei do not have a single fixed appearance. Their intensity and shape can change across cell types and imaging conditions. Unlike manual tracing or image edge detectors, convolutional models can learn hierarchical features, allowing them to delineate boundaries even when contrast is low or when adjacent nuclei partially merge. With data augmentation and validation, a learned model can generalize across common imaging variability and provide consistent while reproducible segmentation that supports accurate counting and clinical quantitative analyses.

Illustration

The project model core idea and flow is shown in Figure 2.

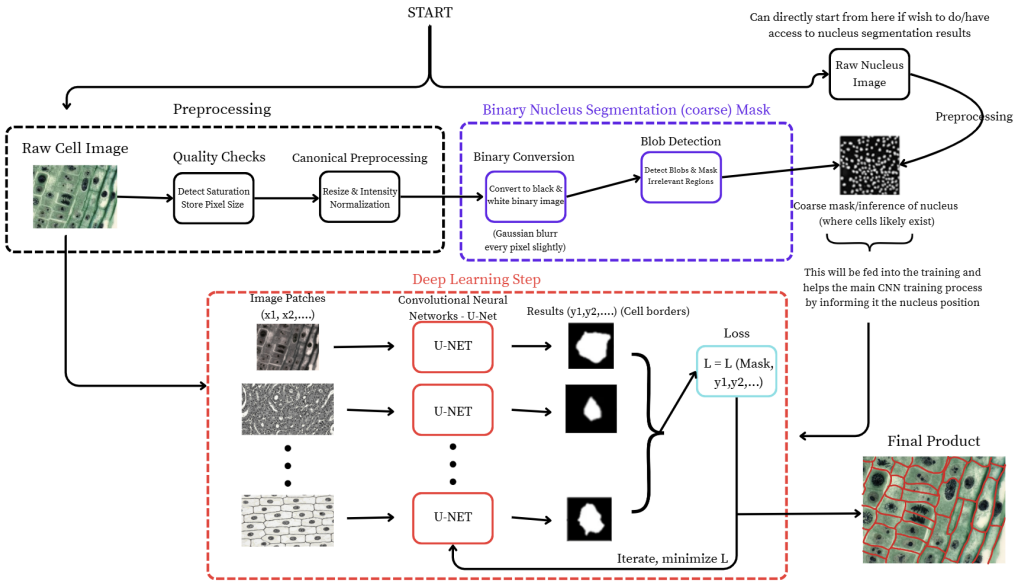

Figure 2: The illustration of the cell segmentation model we will implement.

Background & Related Work

Data Processing

Architecture

Baseline Model

Ethical Considerations

References