
AoE/BME Project

Cell Segmentation With U-Net.

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Cell Segmentation with U-Net

Background & Problem



Background

- Fast and efficient cell identification and segmentation has become important in attempts to explore the role of cellular heterogeneity in dynamic living systems.
- Manual methods of cell segmentation are tedious, time consuming and prone to more errors
- The advancement of machine learning is providing an efficient approach to cell segmentation.
- This project creates and trains a deep learning neural network, U-Net, to perform cell segmentation.



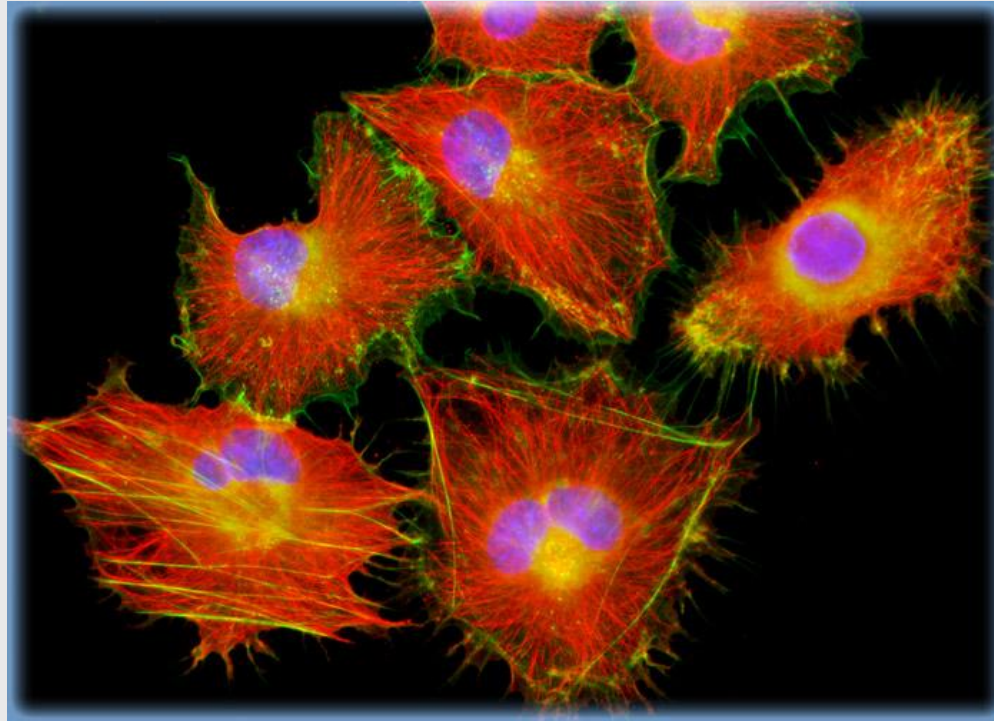
Cell Segmentation with U-Net

Data Acquisition



— Data Acquisition

- This project uses fluorescence widefield microscopy images of nuclear and cytoplasmic live-cell stains of baby hamster kidney (BHK) cell cultures.



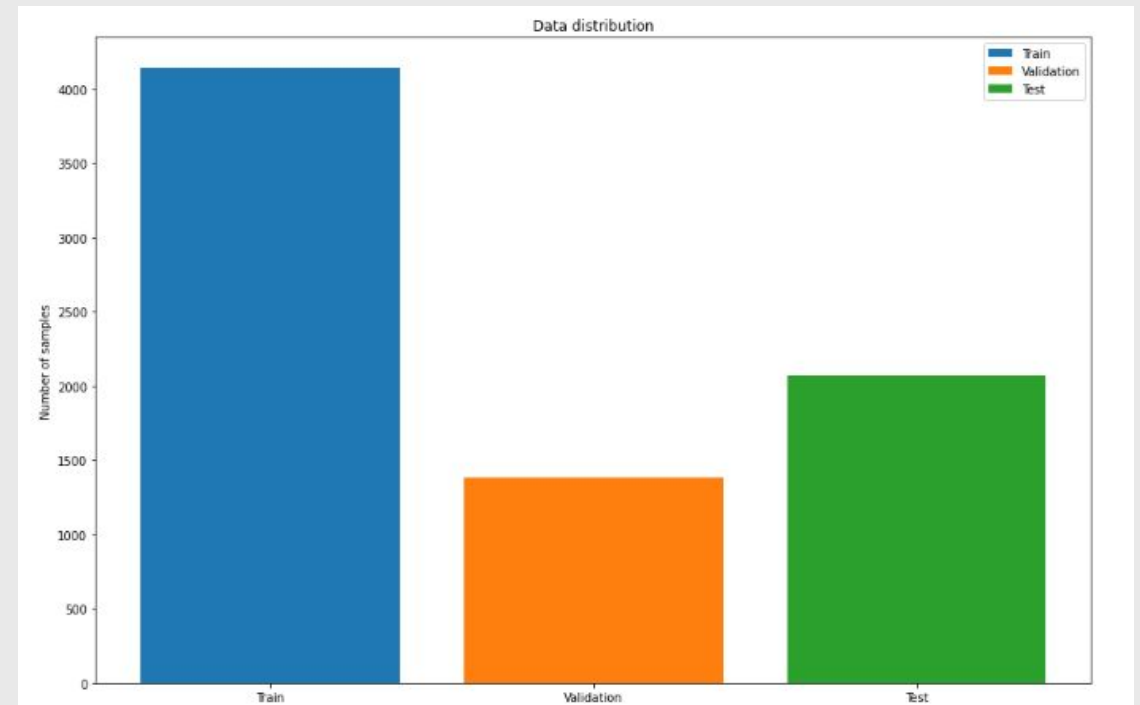
Dataset

Dataset

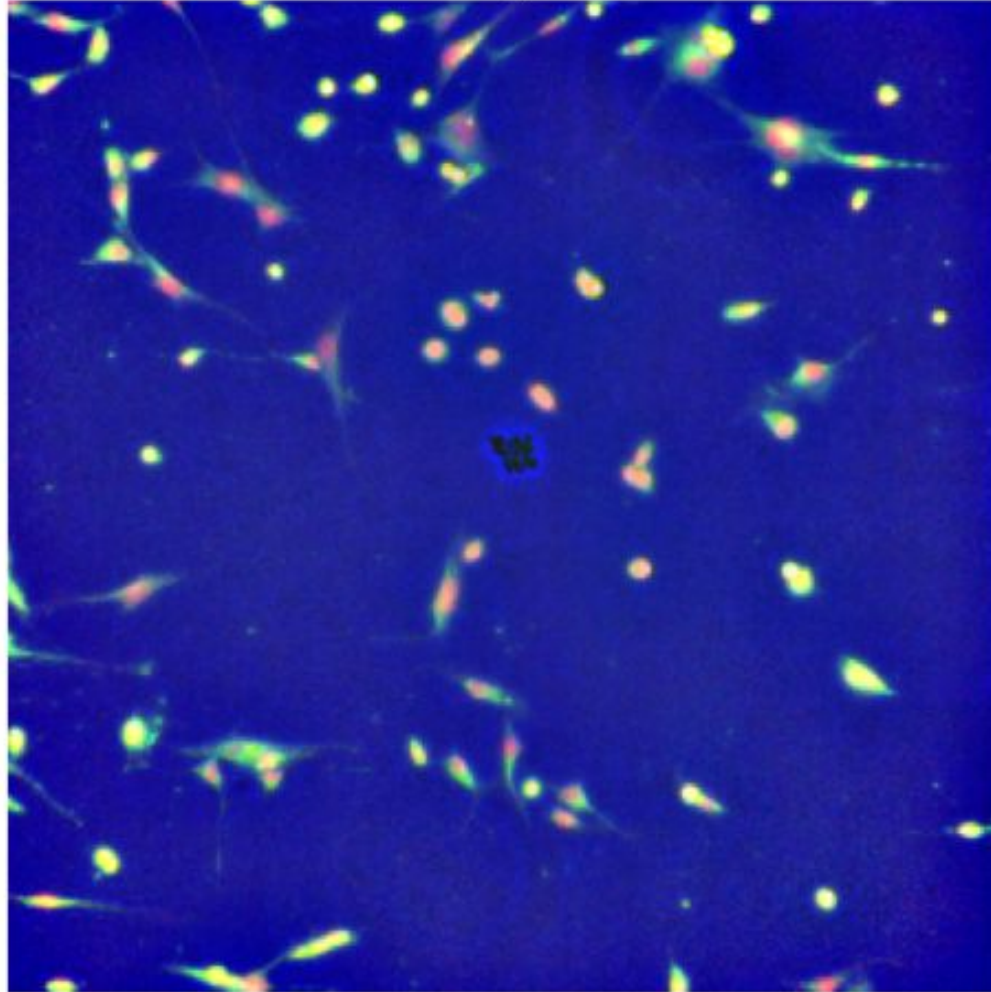


Dataset

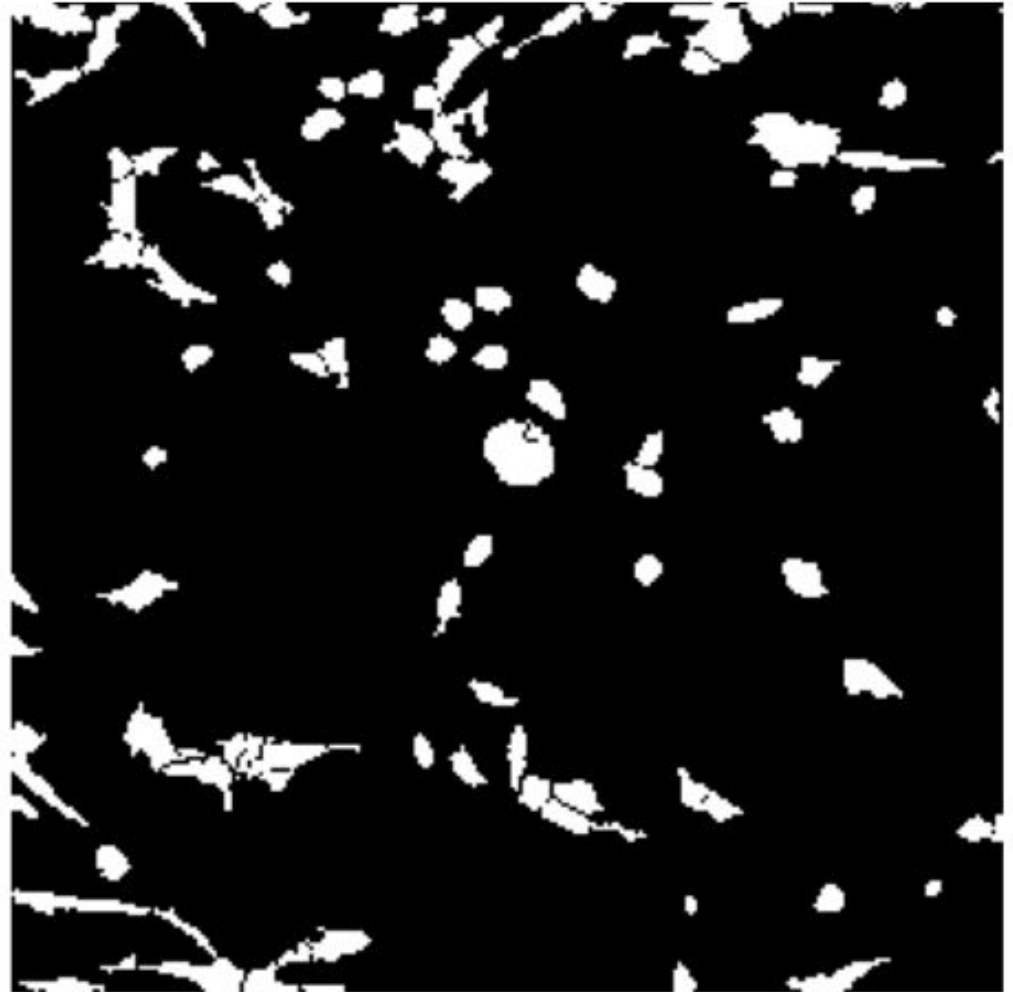
- The entire model makes use of 7590 samples divided into three different sets: Validation, Testing & Training datasets in the ratio 1 : 1.5 : 3
- Training dataset has 4140 samples
- Validation dataset has 1380 samples
- Testing dataset has 2070 samples
- Each sample consists of an image and a corresponding image mask



Image



Mask



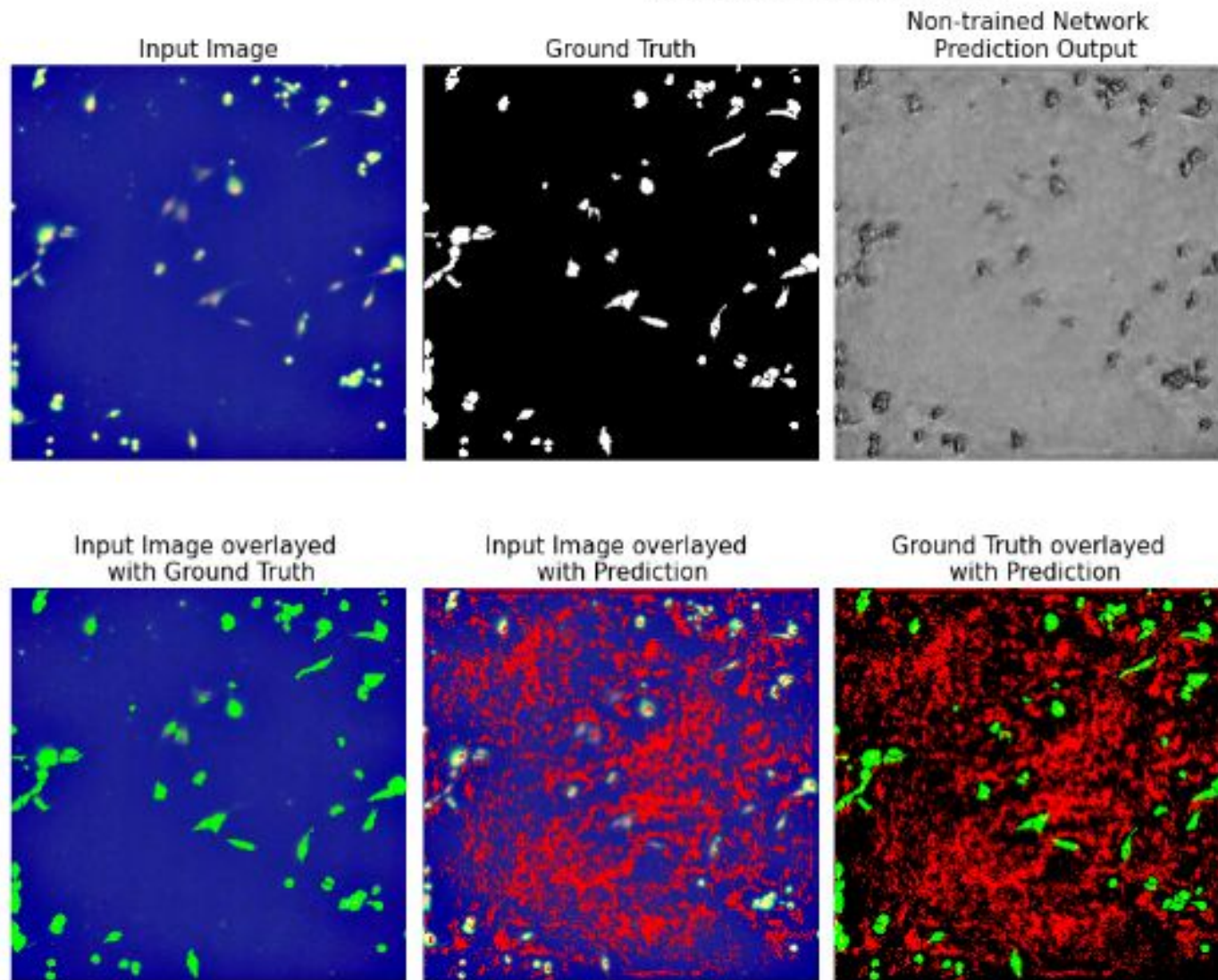
Sample image and corresponding mask

Cell Segmentation with U-Net

Approach



Display of test sample image 1

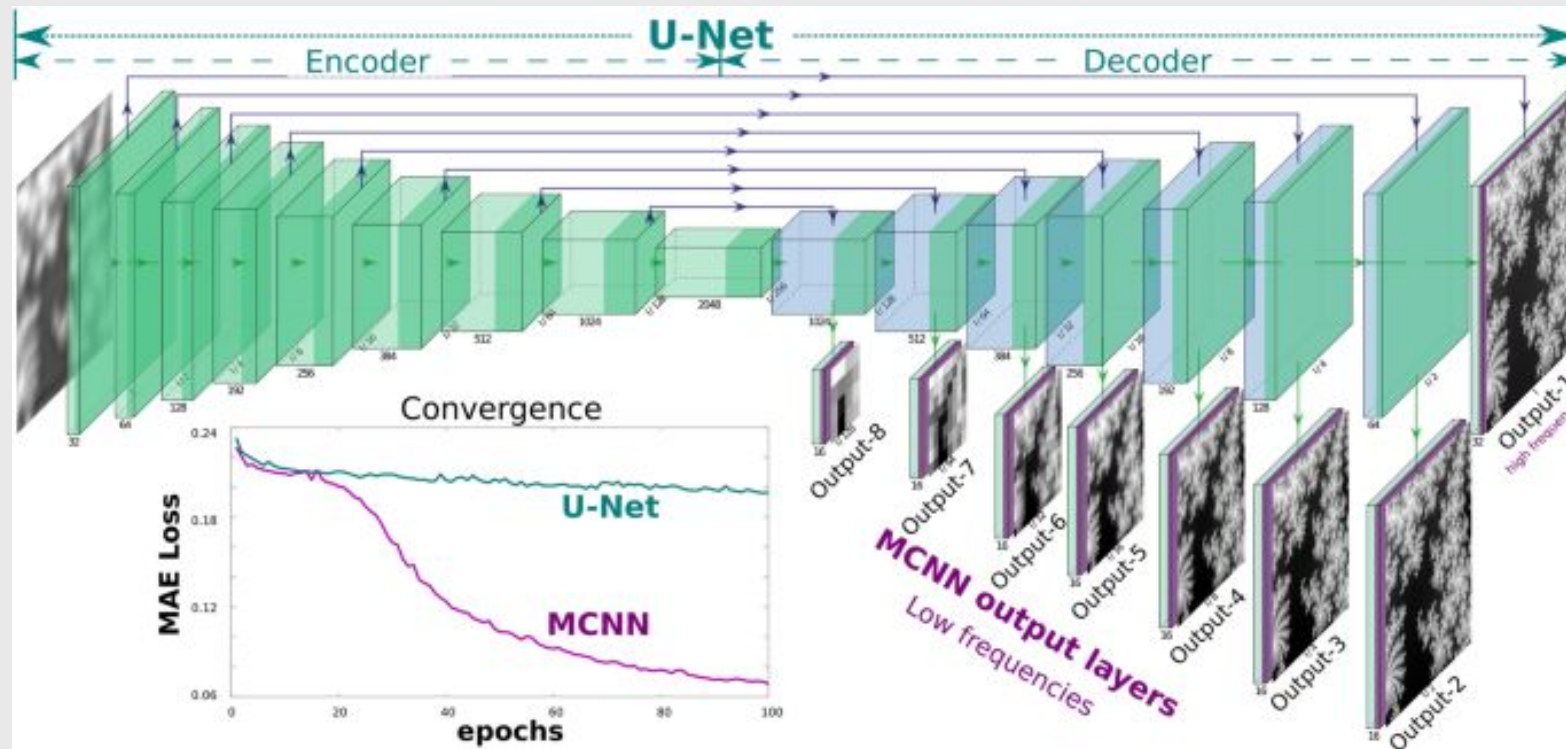


Prediction from untrained model



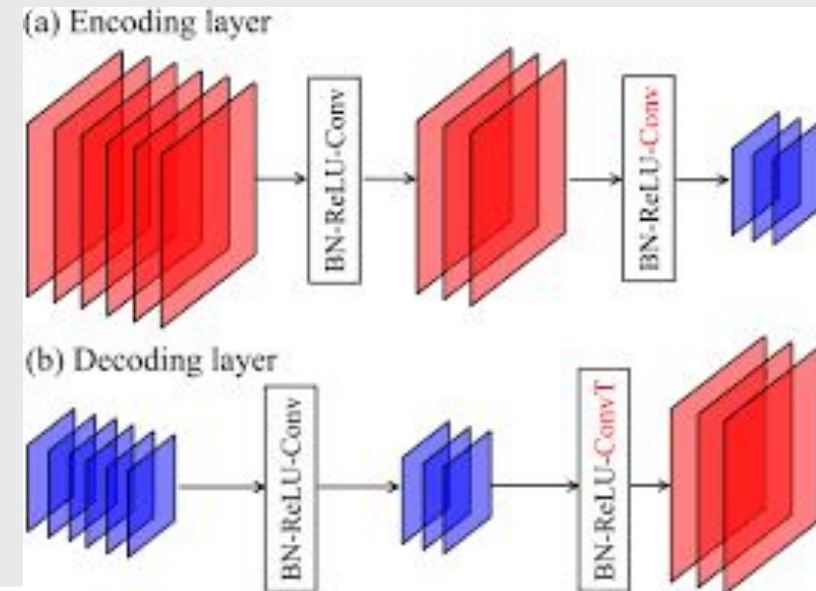
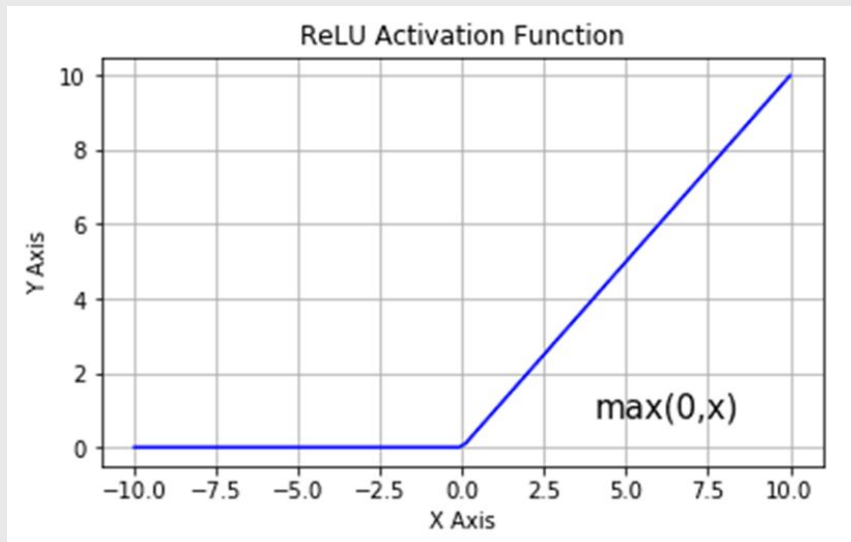
Approach

- U-Net consisting of convolutional layer, pooling layers and a fully connected layer



Approach

- The 2D convoluted layers are produced with kernel of size 3 and padding of 1. ReLU as the activation function applied to outputs
- Model had 4 encoding and decoding layers respectively



— Approach

- U-Net used a Binary Cross-Entropy (log) loss function since this project is a binary classification method. A Categorical Cross-Entropy loss function wasn't optimal since this cell segmentation method has only two classes.
- Utilized the ADAM optimization algorithm since it's the most efficient method and is a combination of Adadelta, RMSProp and Adagrad.
- Training in batches for 50 epochs and used weights from the best epoch (highest validation DICE score) to finalize the model

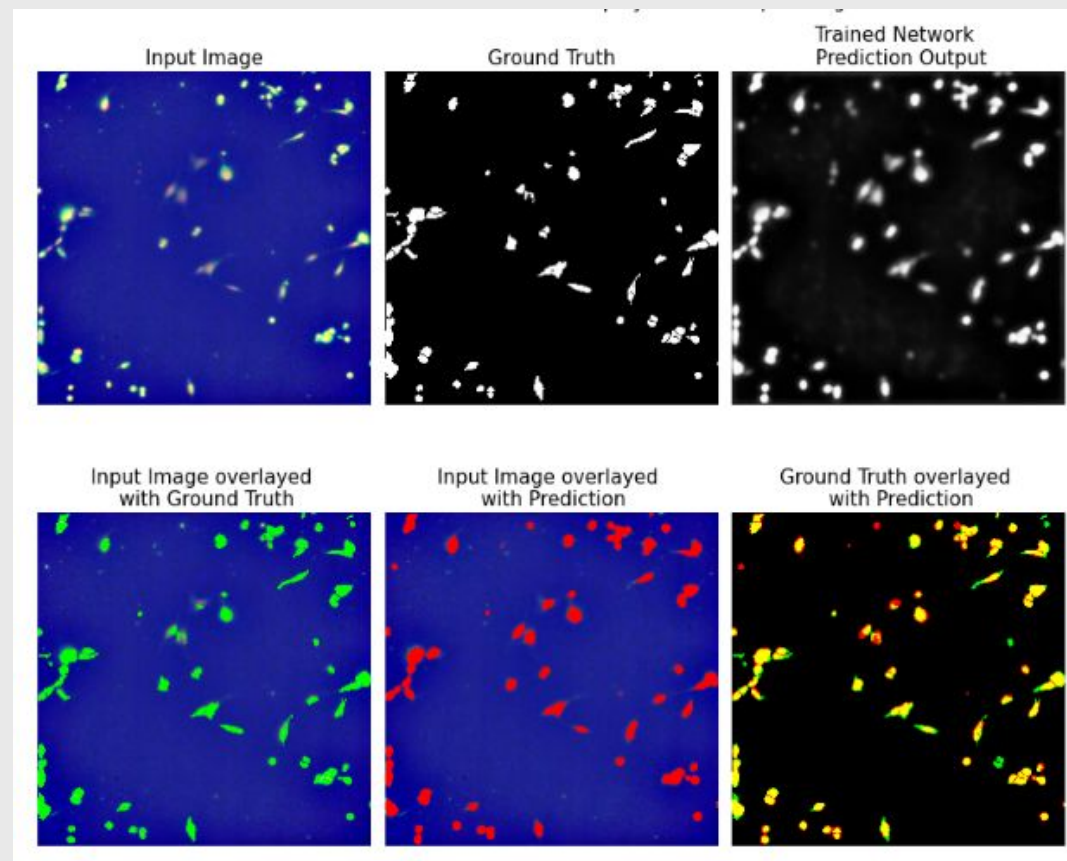
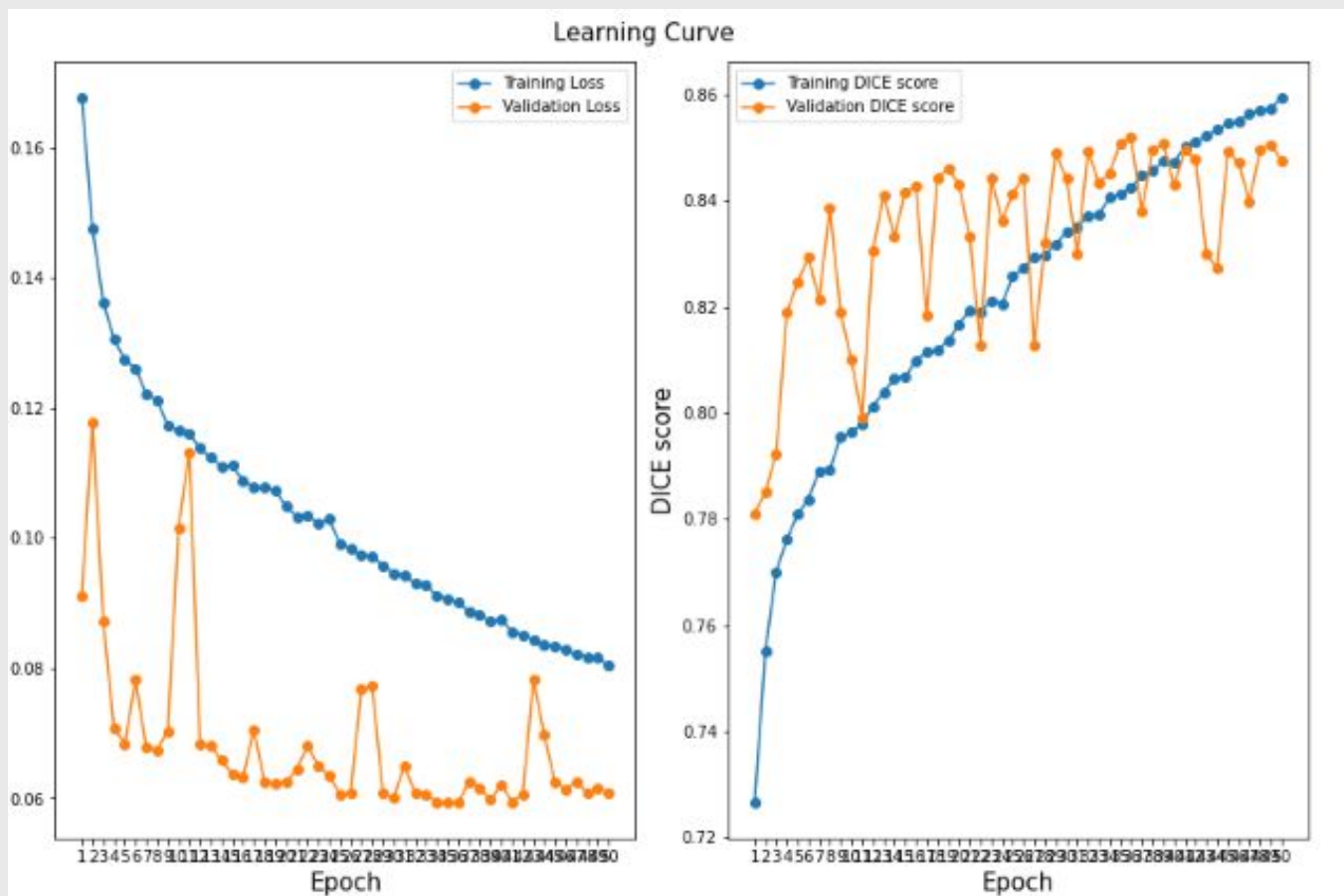


Cell Segmentation with U-Net

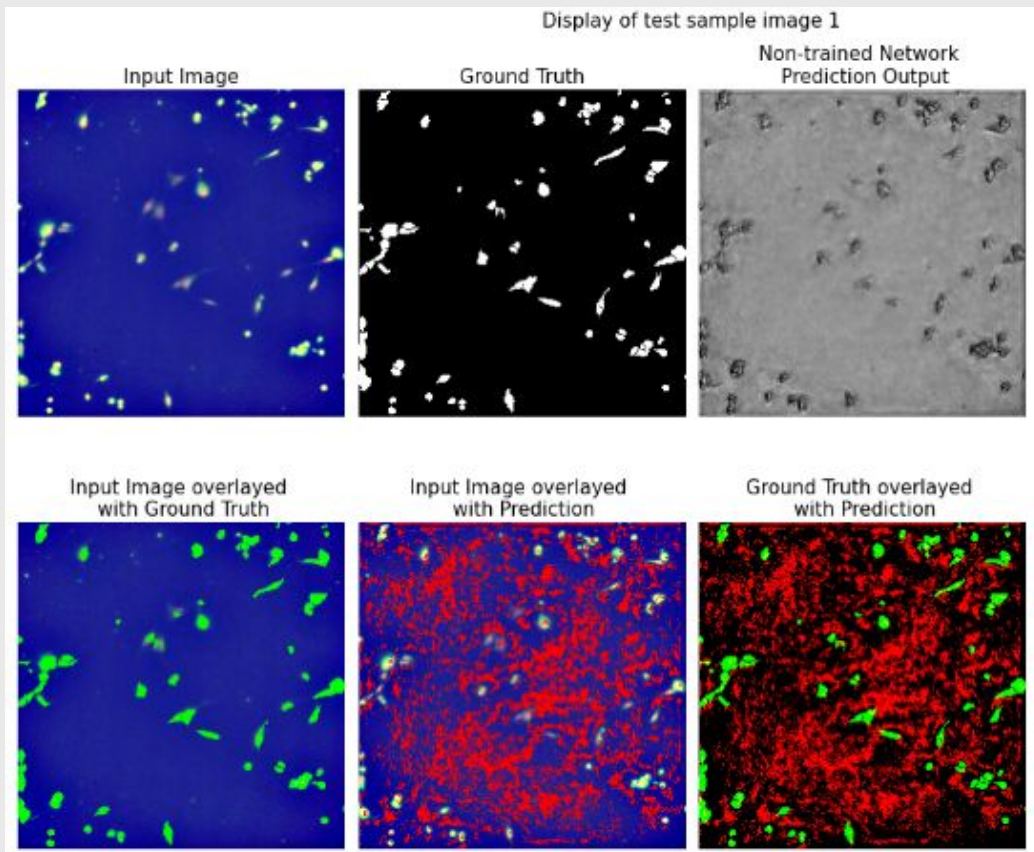
Results



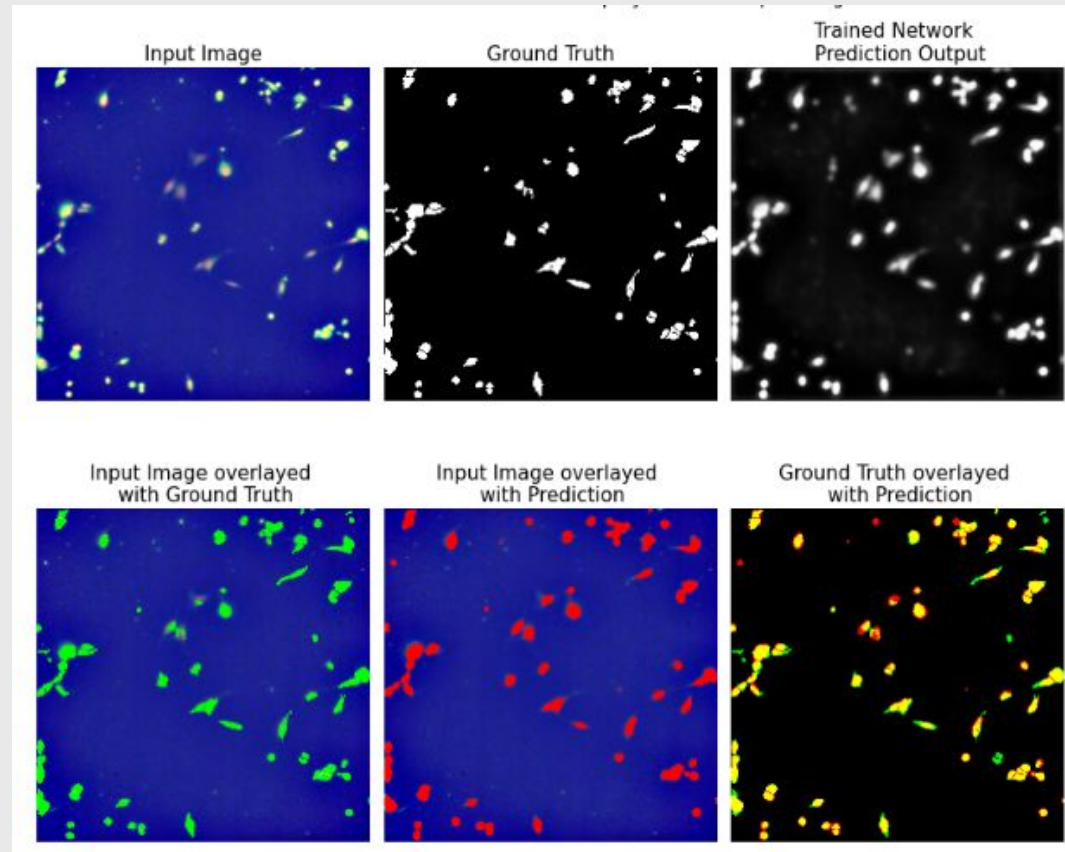
Results



Results

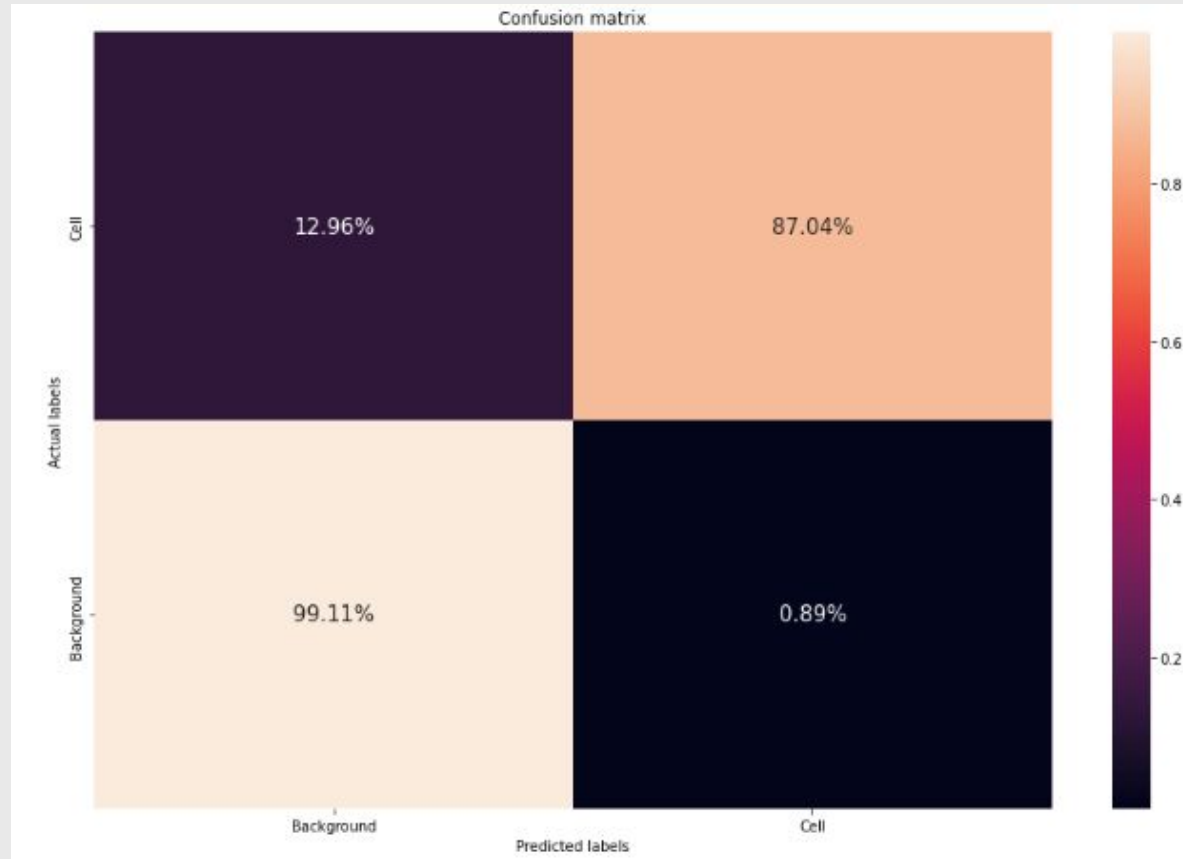


Prediction from untrained model



Prediction from trained model

Results



Prediction from trained model



Cell Segmentation with U-Net

Method of improvement



— Method of improvement

- Improved network design:
 - Increased kernel size to 5 and padding to 2
 - Increased number of encoding and decoding layers to 5 each

