Project Summary: Mitochondria Segmentation using U-Net

Paavni Singh

June 23, 2025

1 Problem

Electron Microscopy (EM) images are vital for studying mitochondria morphology in biomedical research. Manual segmentation is time-consuming and error-prone. This project aims to automate mitochondria segmentation using a U-Net model.

2 Approach

I implemented a U-Net architecture trained on patchified EM images. Data augmentation was used to improve generalization. The model was trained using binary crossentropy loss and evaluated using pixel-wise accuracy, Dice coefficient, and IoU.

3 Dataset

- Dataset: Kaggle Electron Microscopy Dataset - Input: Grayscale EM images - Labels: Binary masks for mitochondria - Preprocessing: Patchified into 256×256 tiles, normalized, and augmented

4 Results

- Pixel Accuracy: **98.61%**
- Dice Coefficient: **0.8563**
- IoU Score: **0.7487**

Sample visualization is shown in Figure 2.

5 Future Work

- Integrate Dice/Focal loss to improve segmentation boundary precision
- Experiment with Attention U-Net or TransUNet for better feature learning
- Deploy model into a biomedical image analysis pipeline or web app

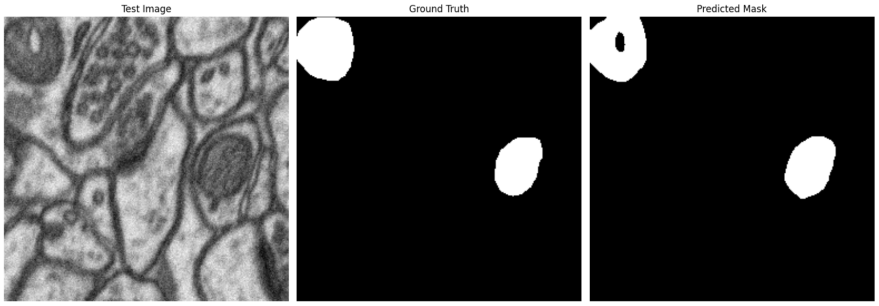

Figure 1: Input image, ground truth, and model prediction

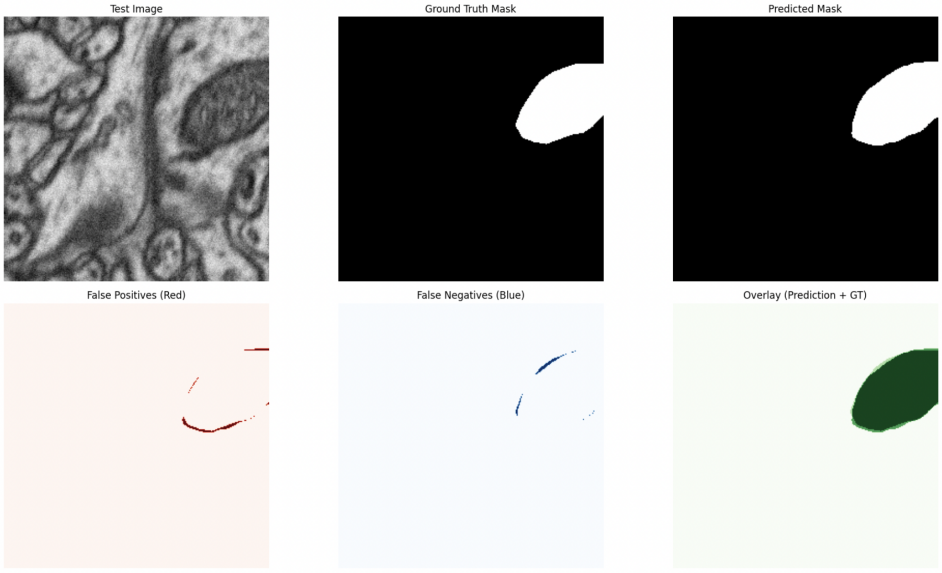

Figure 2: false positive, false negative, and overlay