Project Progress Report

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Dataset

The Electron Microscopy Dataset offers a comprehensive view of a 5x5x5 um section from the CA1 hippocampus region of the brain, translating to a 1065x2048x1536 volume. With a voxel resolution of approximately 5x5x5 nm, the dataset has been graciously provided as structured TIF files for training and validation. Notably, our focus was drawn to this dataset due to its meticulous annotations of mitochondria in two sub-volumes, making it an instrumental tool in our line of research.

Objectives

Primary Objective: Develop a segmentation model capable of effectively working with the dataset, striving to achieve the optimal Intersection over Union (IoU) score.
Secondary Objective: Progress to semantic segmentation with the aim to track specific cell bodies throughout the dataset.

Methodology & Implementation

Initial Steps: We kickstarted our project with histogram segmentation leveraging Otsu's threshold. This approach set the foundational framework upon which subsequent methodologies were implemented.
Post Processing: We implemented a list of operations such as morphological operation, Hole-filling techniques, noise reduction and Connected Compo-

nent Analysis to further improve the accuracy of this histogram segmentation technique.

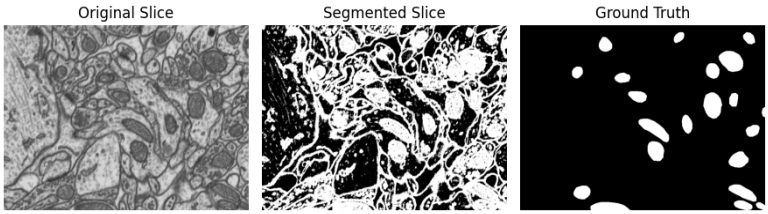

Figure 1: Example prediction of Histogram Segmentation

We achieved an accuracy of up to 80 percent for validation set but the IOU score was a lowly 10-15 percent.

Deep Learning Approach

- Implemented a basic U-Net model with a minimal set of encoders and decoders. This architecture was chosen for its proven track record in segmentation tasks.
- Employed DataGen to manage the dataset effectively and resized images to a manageable 500×500 size for training-validation splits.
- Leveraged the VGGNet architecture as the backbone of our U-Net model, initializing it with pre-trained ImageNet weights for enhanced feature extraction.

Results & Findings

The models, in their preliminary stages, were trained over short epochs (10-15 epochs). This limited training ensures that we have a foundational understanding of the model's performance, with a clear vision to iterate and optimize in future stages.

As shown in Figure 1 and Figure 2, we can see the accuracy differences between the UNET Metrics and VGG UNET Metrics. The model for the VGG UNET shows up to a 62% IOU score. Meanwhile, the model for the UNET shows around a 50% IOU score.

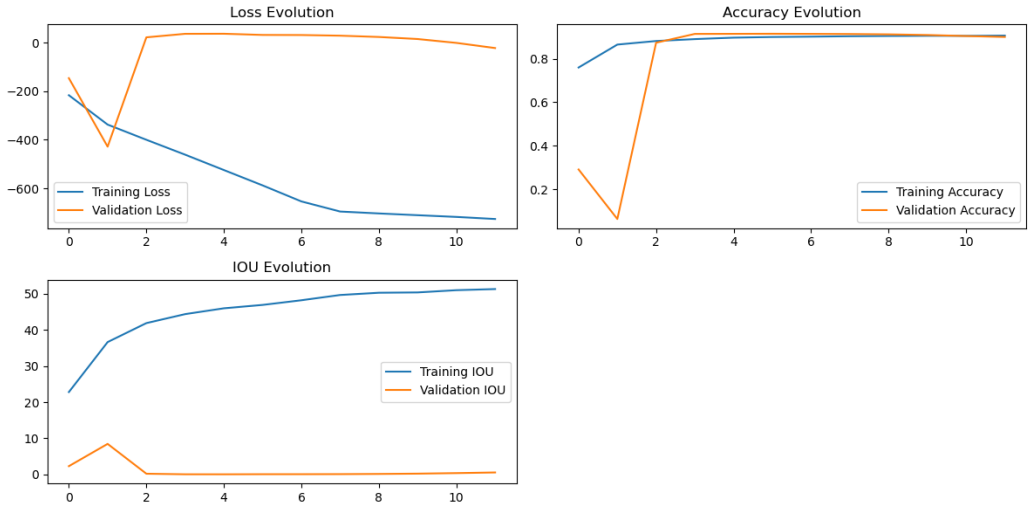

Figure 2: Basic UNET metrics of 10 epochs

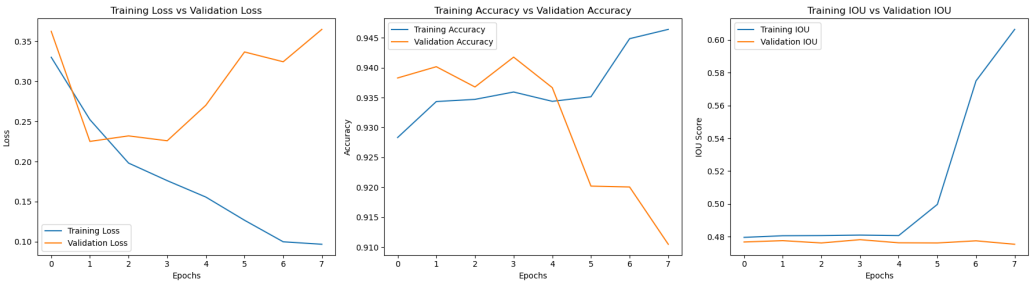

Figure 3: VGG Backbone UNET metrics of 10 epochs

Future Plans & Roadmap

We intend to perform more comprehensive training sessions, tuning hyperparameters to extract the best performance from our models. We will evaluate different architectures and potentially integrate more advanced post-processing techniques based on observed performance.