Contribution ID: **8** Type: **not specified**

Efficient 3D volumetric segmentation of Axon Initial Segments: overcoming large volume data challenges with CNNs and algorithm-assisted labeling.

This study focuses on the application of computer vision, specifically convolutional neural networks, to the task of 3D volumetric segmentation of Axon Initial Segments (AIS) on light sheet microscopy images, with strong emphasis on automatic label generation and handling large image volumes. Our work allows for analyzing AISs in bulk on a scale intractable by human researchers, reducing the time and effort required to annotate samples, which is a crucial step for analyzing the Axon Initial Segments'morphology. We present a pipeline of morphological operations that can extract information from the volumes and output initial labels, which accelerates the process of preparing labels for training. The difficulties and limitations of handling large image volumes are also identified, and proposed solutions are discussed. Furthermore, we explore indirect model optimization approaches that encourage alignment between the distribution of morphological features in the segmented objects and the labels. We conclude with a review of the results obtained with multiple training setups, and a feasibility study of applying computationally intensive loss functions in large volumetric data scenarios.

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Session Classification: Poster Session & Fingerfood