Synapse-Aware Skeleton Generation for Neural Circuits

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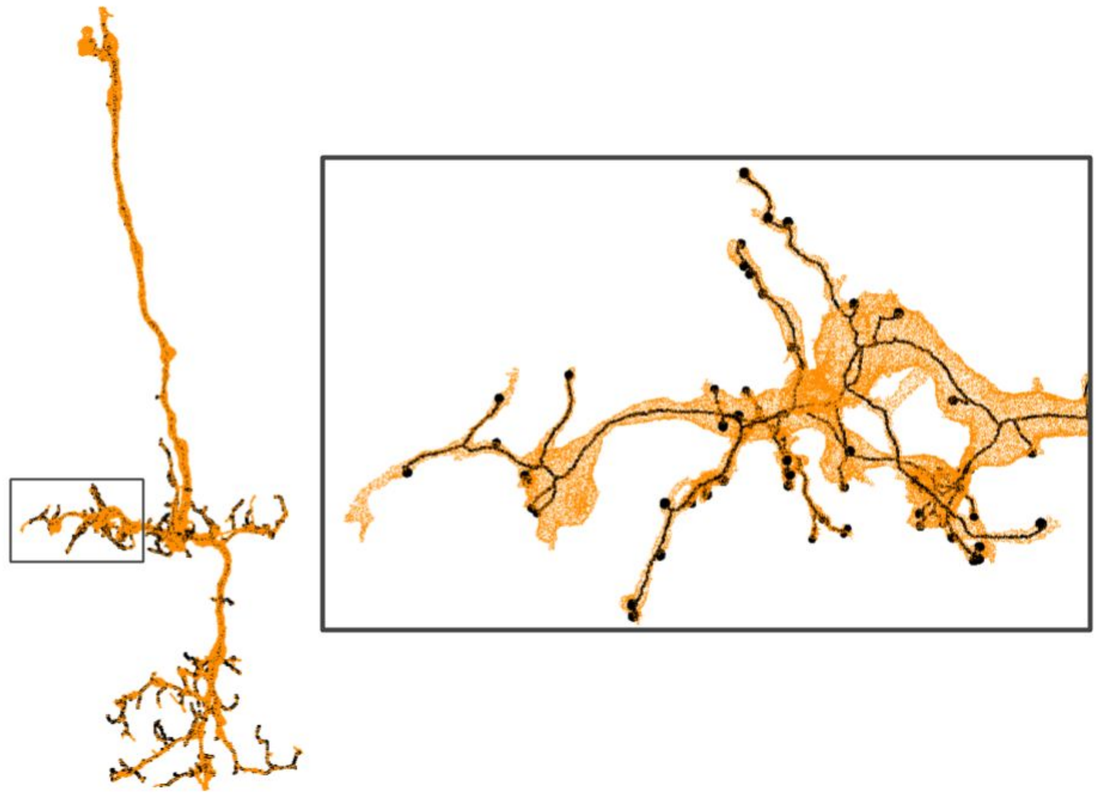
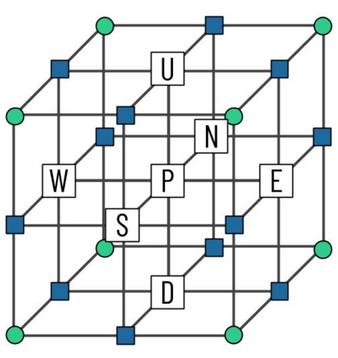
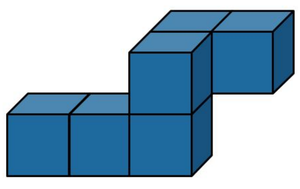
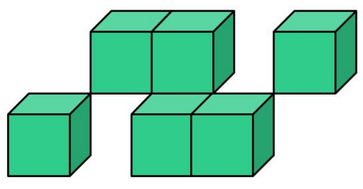
- Reconstructed electron microscopy image volumes contain thousands of interconnected neurons.
- Little research focuses on extracting accurate and expressive wiring diagrams from these datasets.
- Our synapse-aware skeleton generation strategy transforms the volumetric data into an abstract yet expressive format for detailed analysis, accurate simulation, and improved reconstruction.
- Our method achieves a throughput of over 100,000 voxels per second with a one-to-one correspondence between synapses and endpoints.







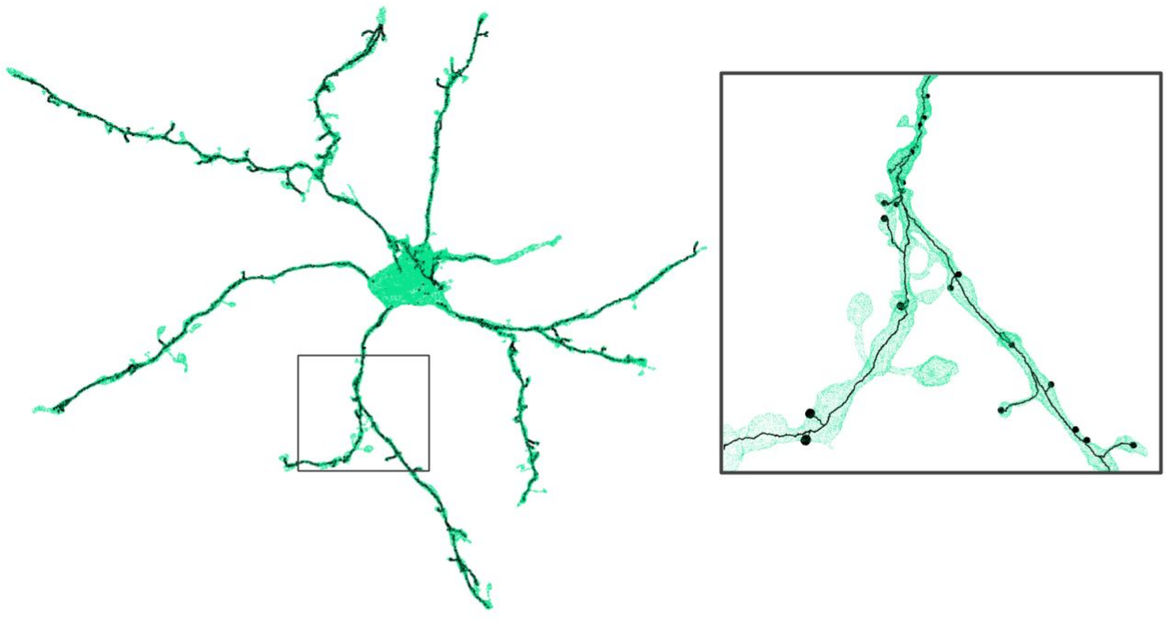
18-Connected

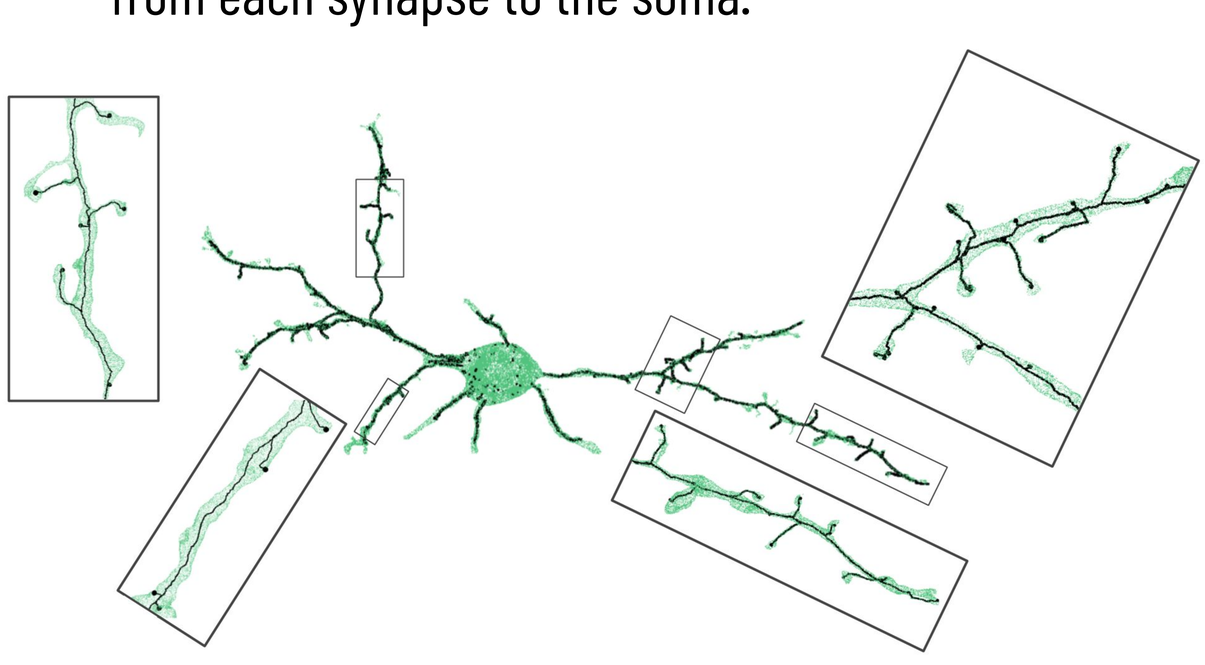


26-Connected

- We build on existing topological thinning strategies that erode surfaces to produce centerlines.
- Our input is a neuron segmentation and corresponding list of synapses.
- The skeleton connects all synapses.
- We concurrently generate accurate width estimates along the skeleton and produce geodesic distances from each synapse to the soma.

- We evaluate our method on 868 neurons and neuron fragments from three different species: rat, fruit fly, and zebra finch.
- We achieve a perfect one-to-one correspondence between synapses and endpoints with an average absolute mean width error of 19 nanometers.





- We outperform TEASER and isthmus thinning approaches on NRI scores by 2.5 to 5x.
- The geodesic distance from each synapse to the soma over all neurons is on average 47% farther (12μm) than the Euclidean distance.
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