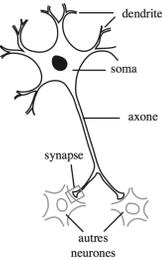


# AUTOMATIC TRACING OF THE DENDRITES IN 3D RECONSTRUCTIONS OF NEURONS OBTAINED BY CONFOCAL MICROSCOPY

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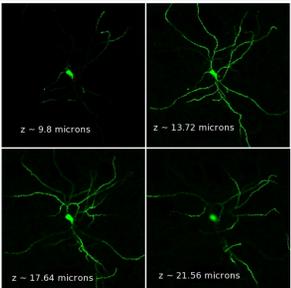
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## Context



**Exploration of the role of certain proteins in the morphological development of the neurons.**

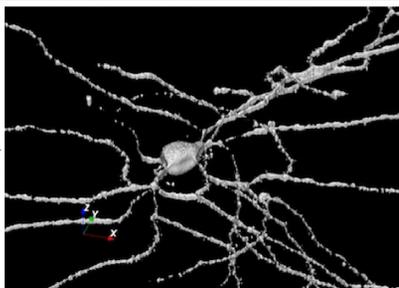
**Need for algorithms able to automatically extract quantitative information about the morphology**



**Image series are acquired using laser-scanning confocal microscopy**

**Reconstruction** →

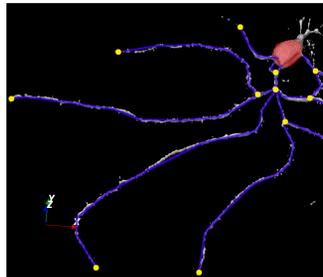
Each image is acquired on one focal plane, which is adjusted along the series so as to form a 3D-stack.



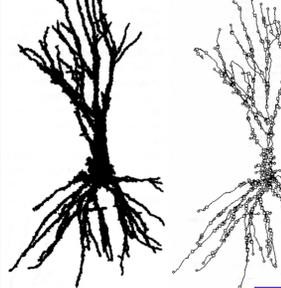
[Source : Roussel, C. Etude du rôle des chélateurs calciques sur les oscillations du potentiel membranaire neuronal : approche expérimentale et théorique, Master's Thesis, Université Libre de Bruxelles, 2006.]

## Research objectives

Extracting from the image series a tree representative of the connectivity of the dendrites, with the soma as root, and all dendrites correctly identified & connected.

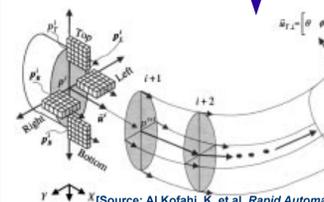


## Tracing or Skeletonization



**Skeletonization** of the neurons is achieved by removing the outer layers of the surface until only the medial axis remains.

**More generic** ✓



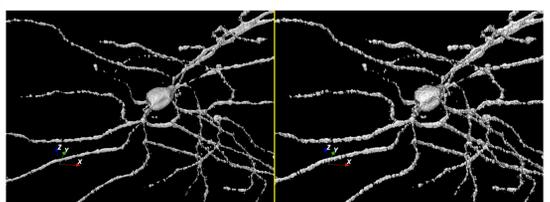
**Tracing** uses local properties of the image to recursively move along the skeleton, starting from a seed point and detection junctions along the way

**Less expensive**

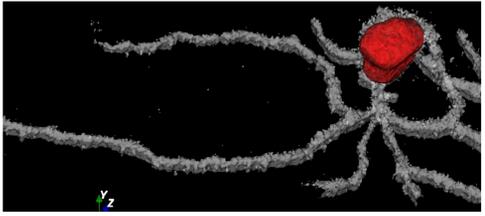
[Source: Cohen, A et al. Automated Tracing and Volume Measurements of Neurons from 3-D Confocal Fluorescence Microscopy Data, J. of Microscopy, 173-2, pp103-114, 1994]

[Source: Al Kofahi, K. et al. Rapid Automated Three-Dimensional Tracing of Neurons from Confocal Image Stacks, IEEE Transactions on Information Technology in Biomedicine, 6-2, pp171-187, 2002]

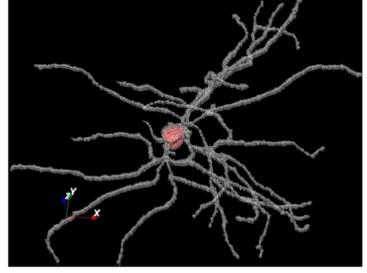
## Algorithm



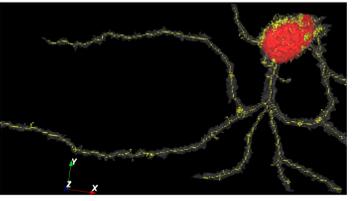
**Resampling**  
Reduce size & change voxel dimensions to cubes



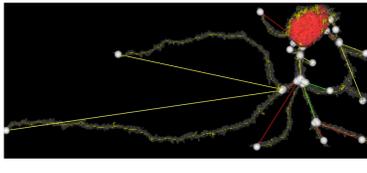
**Soma Detection**  
Thresholding & morphological opening



**Segmentation**  
Region growing with the soma as seed, and an intensity threshold as stopping criterion.

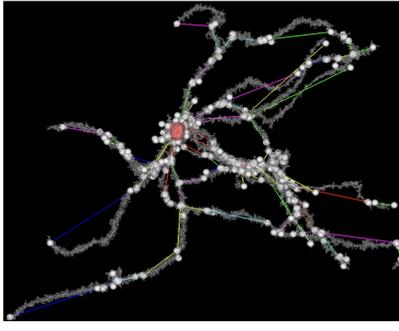


**Skeletonization**  
Very sensitive to small irregularities in the surface of the segmented objects



**Graph extraction**  
Detection of junction & terminal points, graph found recursively starting from the soma, then pruned to eliminate irregularities.

## Results

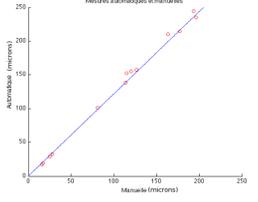


**Test :**  
Are the dendrites correctly connected, and are their length coherent with manual measurements ?



**Result :**  
~80% of dendrites are correctly connected.  
Most errors related to segmentation mistakes.

**Conclusion**  
Algorithm shows promising results, but will require future work, most notably on the segmentation problem. Future work will also focus on the possibility of working at higher resolutions or voxel depth (currently 8-bits).



Manual vs Automatic measurements (dendrites length) shows coherent results