Automatic Segmentation of Neuron Images for 3D Reconstruction

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Neuron Reconstruction Needs and Challenges

- Structural Neurobiologists use 3D models to analyze the structure of the brain
- Eg. analyzing structural changes in developing brain
- Reconstruction requires traces of neuron boundaries in Electron Microscope images
- Takes months to do this by hand!
- Billions of neurons, even more dendrites, measuring 10's of micrometers.
The Goal

- Why not do it automatically?
- Accurately segment cell bodies in electron micrograph images using image processing
Methods - Non-Linear Filtering

- Anisotropic Diffusion
- Median Filtering
- Truncated Mean
- Histogram flattening v. no histogram flattening
- Preparations for classification
Methods - Classification

- Kmeans and seeded region growing - bad
- Random Forest classifier for detecting boundaries
  - DoG
  - Laplacian
  - Gabor filter
  - Kuwahara filter
- Boundary learning with Topological Constraints
Methods - Binary Image Processing and Labeling

- Binary image operations
- Comparison with ground truth traces
  - Pixel error
  - Rand error
  - Warping error
- Region labeling / tracing
## Results - Classification Accuracy

- **True Positive Rate:** 89.9%
- **False Positive Rate:** 33.5%
- **Rand and warping error**

<table>
<thead>
<tr>
<th></th>
<th>Predicted Membrane</th>
<th>Predicted Body</th>
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</thead>
<tbody>
<tr>
<td>Actual Membrane</td>
<td>179670</td>
<td>20097</td>
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<tr>
<td>Actual Body</td>
<td>284642</td>
<td>564167</td>
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</tbody>
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Results - Reconstruction

Traced by Our System

Traced by Neuroscientists
Special Thanks

- Larry Lindsey, UT Center for Learning and Memory
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