Automatic segmentation of punctate 3D super-resolution microscopy data

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May 23, 2016
Expansion Microscopy

- Small structures with light-based microscopes

Source:
Chen et al, Science 2015
Dendritic spines

- Where synapses occur, connecting neurons
- Dendritic spines are too small to see with light, so usually imaged with electron microscopy (EM)

Source: public domain by user CopperKettle
Dendritic spines

- Spines on dendrites on neurons
- Too small to see with light, so usually done with electron microscopy (EM)

Source: public domain by user CopperKettle

Source: Jae-Byum Chang, in publication, 2016
Connectomics

- Mapping connections in the brain
- The challenge: telling neurons apart in an automated way
- Methods exist for low resolution, but not high
Challenges

- 1080 x 1200 x ~200 – almost 1GB!
- Punctate
Our Solution

- Mask
- Clustering
- Connect components
Step 1: Mask

- Provided as an “oracle” to discard pixels
- Convolutional neural network
With mask applied
Step 2: Clustering

- **K-means:**
  Classify similar points together, forming k groups

- **RGB vs RGBXYZ**

- **Choice of k**
The effects of masking on clustering
Step 3: Connected components

- Each “neuron” is actually made up of multiple, slightly differing centroids
- Merge together regions that touch
- After, combine individual slices to create the final product
Results
Future work

- Differentiating within a region
- Memory usage
- Further merging
- Using more of the z axis for further benefits
Acknowledgements

- My mentors
- MIT PRIMES
- The Boyden lab
- My Family
- The brain, both for being amazing to study and amazing to study with
Questions?