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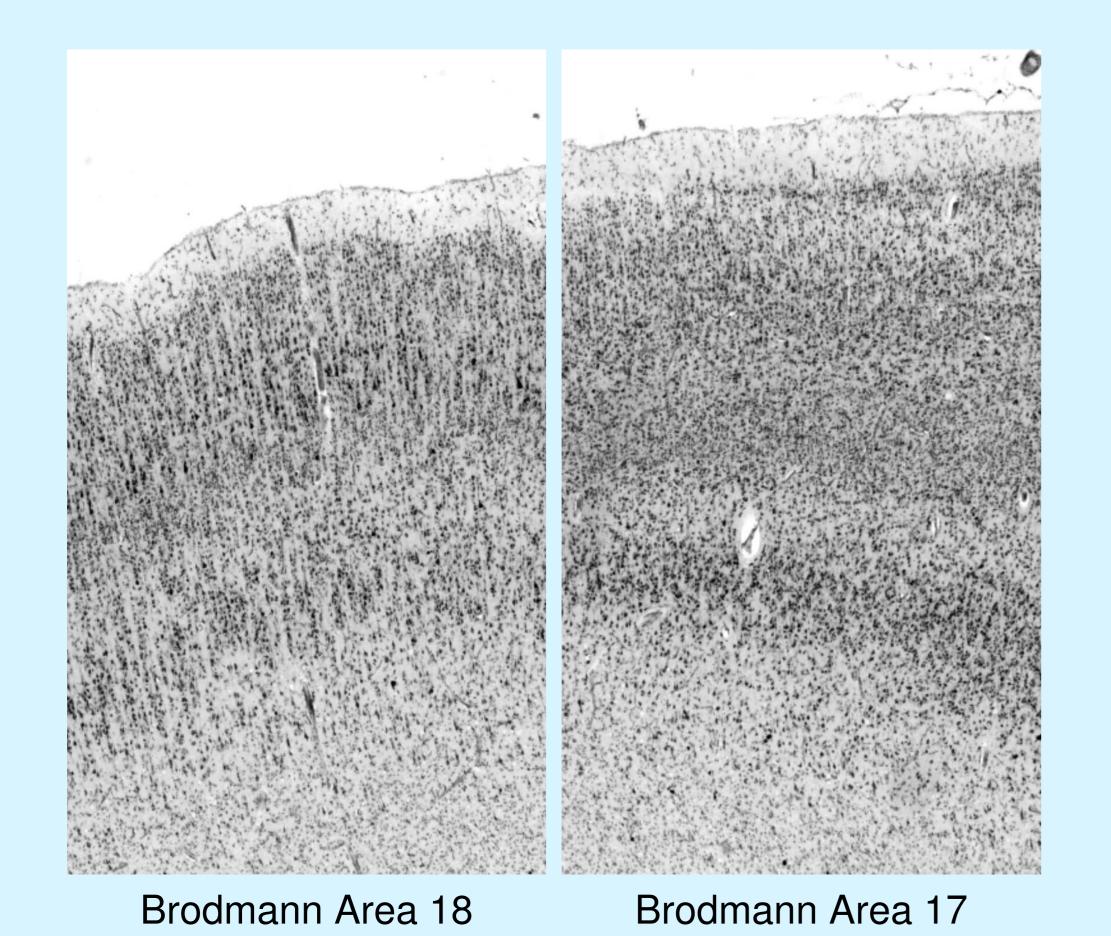
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Deep Learning and Unsupervised Clustering for Analysis of Cellular Structures in the Human Brain

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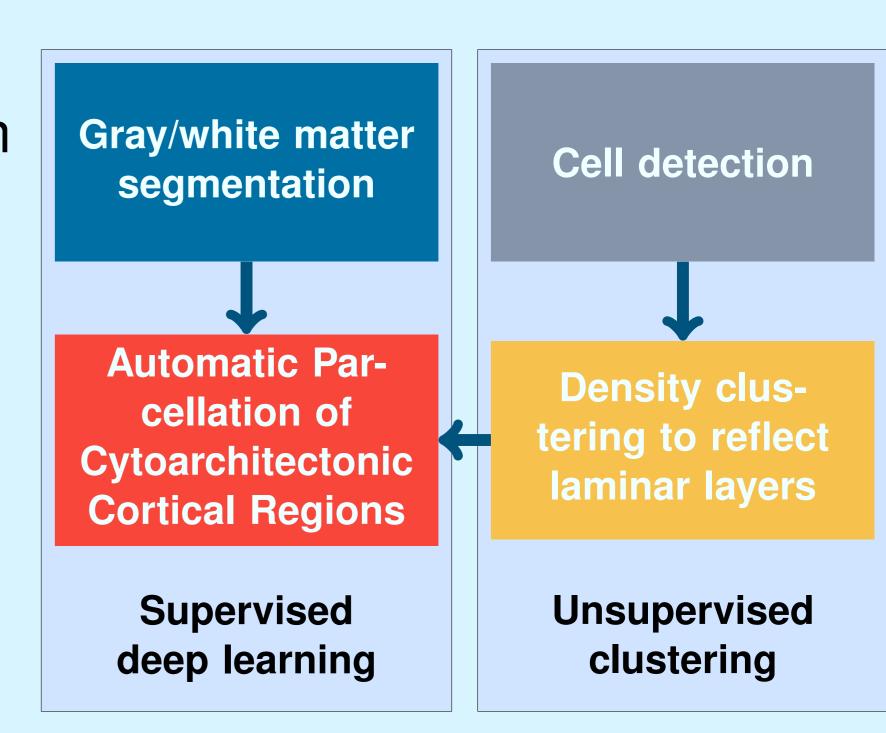


Cytoarchitectonic Mapping n cytoarchitectonic areas [5]. Classical met

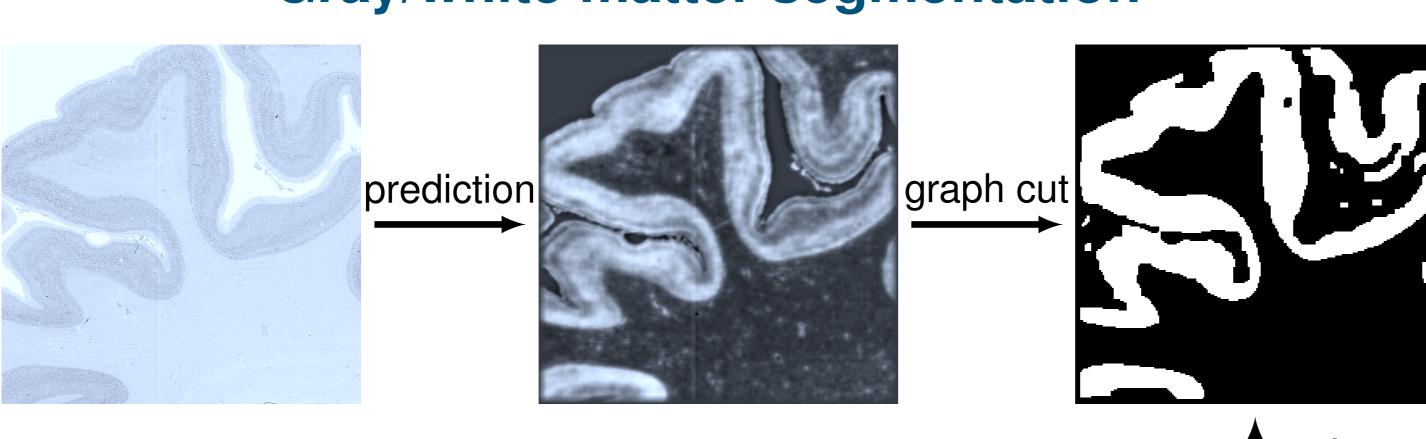
Layer structure differs between cytoarchitectonic areas [5]. Classical methods to locate borders include image segmentation, mathematical morphology, and correlation of local intensity profiles.

Goals:

- Investigate the potential of modern machine learning techniques to support the analysis
- Increase degree of automatization (towards high throughput processing)
- Find qualitative and quantitative measures for cellular distributions



Gray/white matter segmentation



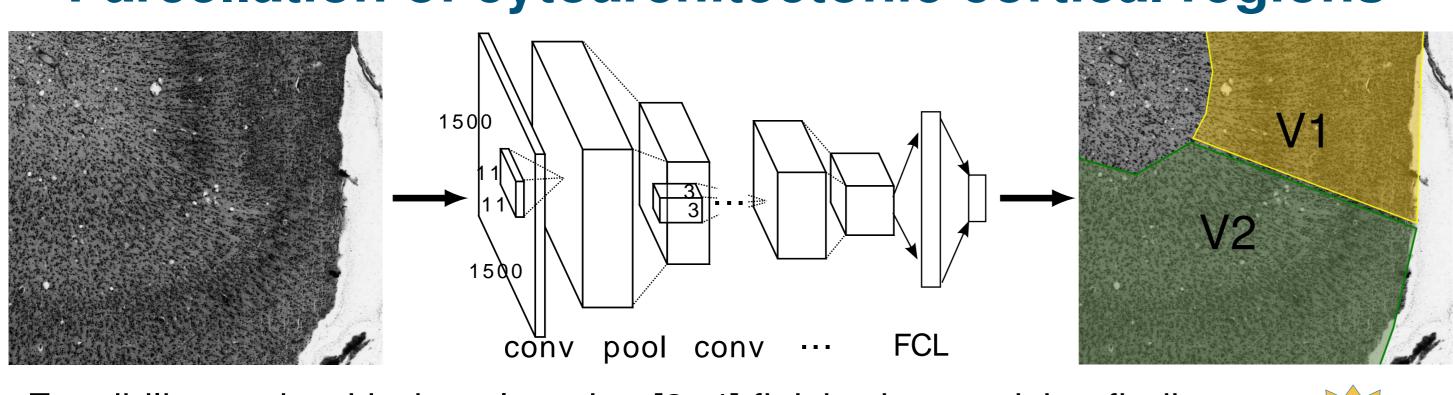
- Use Deep-CNNs [3] to predict cerebral cortex tissue
- Hand crafted masks partially available
- Post-processing to find optimal results (e.g. Graph Cut)
- Prediction for high resolution images parallel on HPC

Next steps

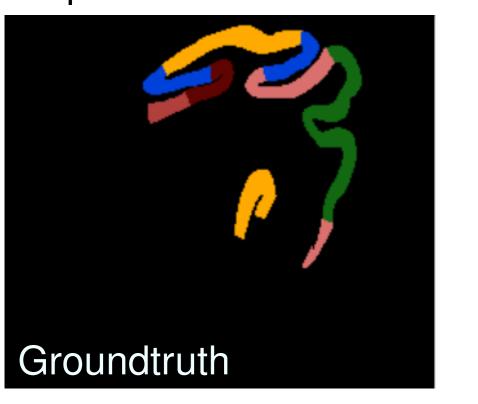
- Increase classifier size / Improve post-processing
- Enhance masks

evaluate

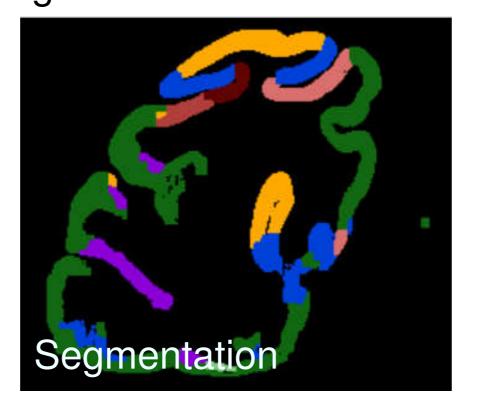
Parcellation of cytoarchitectonic cortical regions



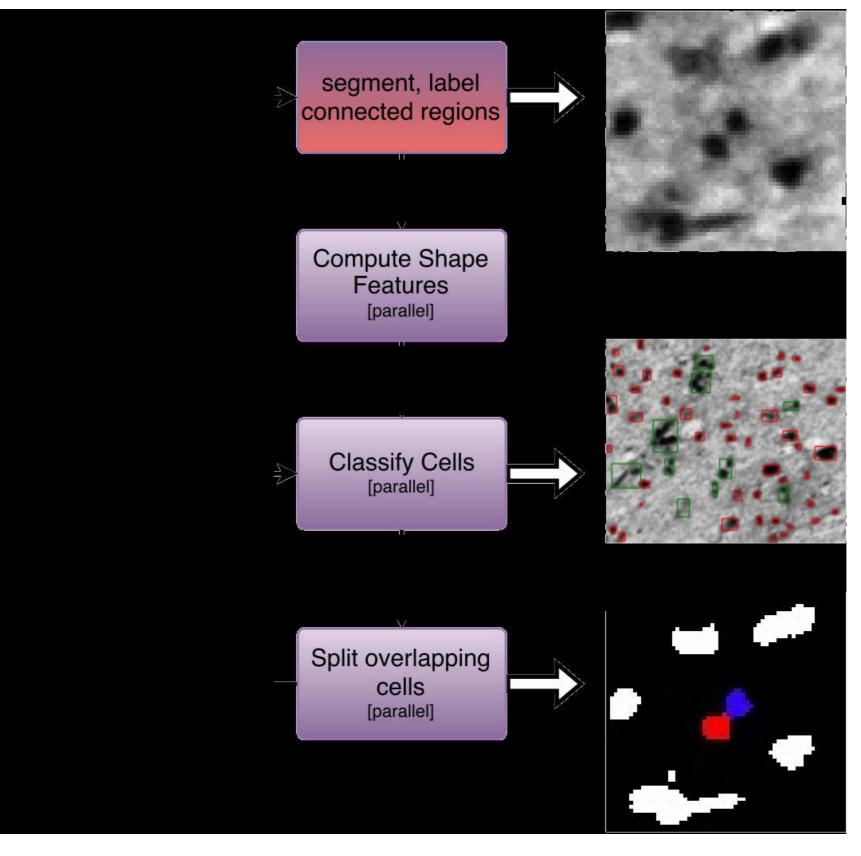
- Feasibility study with deep learning [3, 4] finished promising findings
 Next steps
- Implement workflow on HPC to enable processing of larger amounts of data







Cell detection



- Compute shape attributes for each connected region
- Random Forest / SVM for prediction

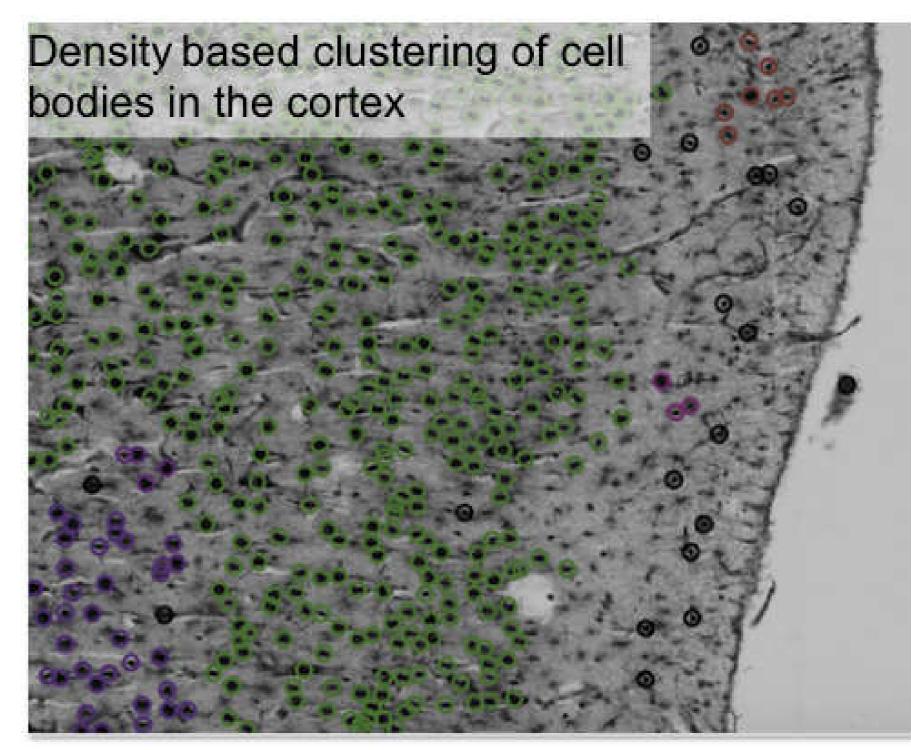
Next steps

- Split cells using clustering, parallel for each label
- Create a unicore workflow



Density clustering to reflect laminar layers

- Cortical areas show different cell densities
- Using density based clustering (DBSCAN [1]) to find regions of different density
- Scalable and parallel HPDBSCAN [2] implementation to cluster large number of cells



Next steps

- Compare results with different clustering techniques
- Find relations to cytoarchitectonic cortical regions

References

[1] Martin Ester, Hans-Peter Kriegel, Jörg Sander, and Xiaowei Xu. A density-based algorithm for discovering clusters in large spatial databases with noise. In *Kdd*, volume 96, pages 226–231, 1996. [2] Markus Götz, Christian Bodenstein, and Morris Riedel. Hpdbscan: highly parallel dbscan. In *Proceedings of the Workshop on Machine Learning in High-Performance Computing Environments*, page 2. ACM, 2015. [3] Yann LeCun and Yoshua Bengio. Convolutional networks for images, speech, and time series. *The handbook of brain theory and neural networks*, 3361(10):1995, 1995. [4] Yann LeCun, Yoshua Bengio, and Geoffrey Hinton. Deep learning. *Nature*, 521(7553):436–444, 2015. [5] A Schleicher, Katrin Amunts, Stefan Geyer, P Morosan, and Karl Zilles. Observer-independent method for microstructural parcellation of cerebral cortex: a quantitative approach to cytoarchitectonics. *Neuroimage*, 9(1):165–177, 1999.