Learning to predict cutting angles from histological human brain sections

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Problem Identification of obliquely cut regions in histological human brain sections



Histological processing

- Postmortem human brains
- ~7000 coronal sections
- Cell body staining
- Light microscopic scanning
- Resolution: 1µm / pixel









oblique (bad)



straight (good)

Challenge: Oblique cuts

- Cytoarchitecture analysis relies on cortical layers
- angle is too oblique



Layers not visible if cutting

Method **Convolutional Neural Networks for** automatic cutting angle prediction

Cutting angle computation in BigBrain [1]

- BigBrain: High-resolution 3D brain model reconstructed from
- 7404 sections (20 μ m isotropic resolution)
- Exact cutting angle computation based on 3D context



Convolutional Neural Network for angle prediction

- Project cutting angles in BigBrain to unregistered sections
- Train U-Net [3] for regression [4] of angles from histology
- Patchwise processing: 512px at 64µm resolution
- Training: 384'000 patches from 55 sections
- Testing: 15 sections not seen during training
- L2 loss restricted to cortical ribbon
- Intensity+geometric augmentation promotes transferability

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Result Automatic identification of oblique cuts based on cutting angle prediction





Test error in BigBrain

Conclusion

References

1.Amunts, K. et al. Julich-Brain: A 3D probabilistic atlas of the human brain's cytoarchitecture. Science 369, 988--992 (2020). 2.Lewis, L. et al. (2014). "BigBrain: Initial Tissue Classification and Surface Extraction". In: OHBM Annual Meeting 3.Ronneberger, O. et al. (2015). "U-Net: Convolutional Networks for Biomedical Image Segmentation". In: MICCAI. Springer, pp. 234–241. 4. Meyee, I. et al. (2018). "A pixel-wise distance regression approach for joint retinal optical disc and fovea detection". In: MICCAI. Springer, pp. 39-47.

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Prediction in 2nd unseen brain

Cutting angle prediction helps to identify oblique cuts • Predictions on unseen brains demonstrate transferability • Next: Excluding oblique cuts from downstream analysis tasks