Toblerone: partial volume estimation on the cortical ribbon

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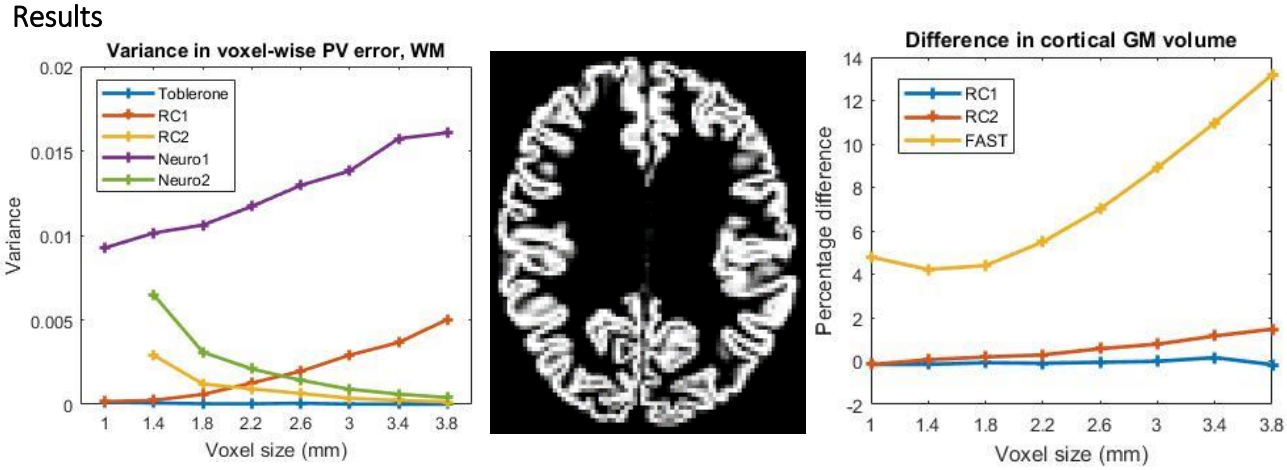
Introduction

Partial volume (PV) effects present a challenge for functional image analysis [1]. Correcting for these requires PV estimates, usually obtained via Gaussian mixture models. A novel approach is to use the surface boundaries between tissue regions identified by tools such as FreeSurfer [2], whereby PVs are estimated by considering the intersection between surfaces and the voxels of an image. This may be more accurate than conventional methods. The Toblerone algorithm has been developed for this purpose and focusses specifically on the human cortex.

Methods

PV estimates produced by Toblerone were evaluated using both simulated brain surfaces (ground truth) and real brain surfaces (fifty subjects from the Human Connectome Project). Results from two other surface-based PV estimation techniques [3, 4], alongside a conventional method (FSL's FAST [5]), were also obtained. Voxel resolutions of 1 to 3.8mm isotropic were investigated.

Results



L: Variance of voxel-wise error, simulated surfaces. C: Cortical GM PV map, 1mm isotropic voxels, real surface. R: Systematic differences in cortical tissue volumes (referenced to Toblerone) on real surfaces, in agreement with simulation results.

Results from the simulated surfaces show that Toblerone produces estimates with consistently low mean error and the smallest variance of all methods. Results from real surfaces show systematic differences that are similar to those observed in the simulated data.

Conclusion

Toblerone provides a new method for estimating partial volumes on the cortical ribbon. Performance (mean and variance of error on simulated surfaces) was consistent across a wide range of voxel resolutions and the resultant estimates differ to those provided by conventional methods. Similarity in systematic differences between real and simulated data suggests performance would transfer over to real use cases.

References

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