Continuous Trajectories from Discrete Anatomical Shapes

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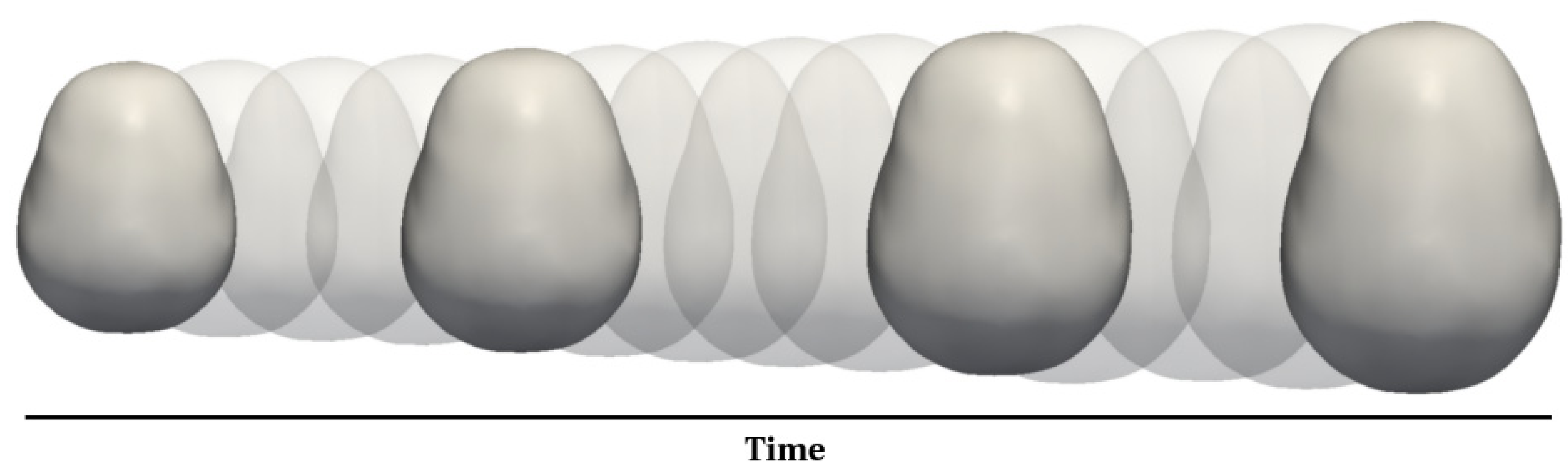
Introduction

The study of time dependent shapes is an emerging field in Computational Anatomy, with potential application to early brain development, aging studies, or the analysis of evolving pathologic structures. As longitudinal data becomes more widely available, the need for computer models of anatomical evolution becomes increasingly important. In this work, we propose a new type of growth model parameterized by acceleration.

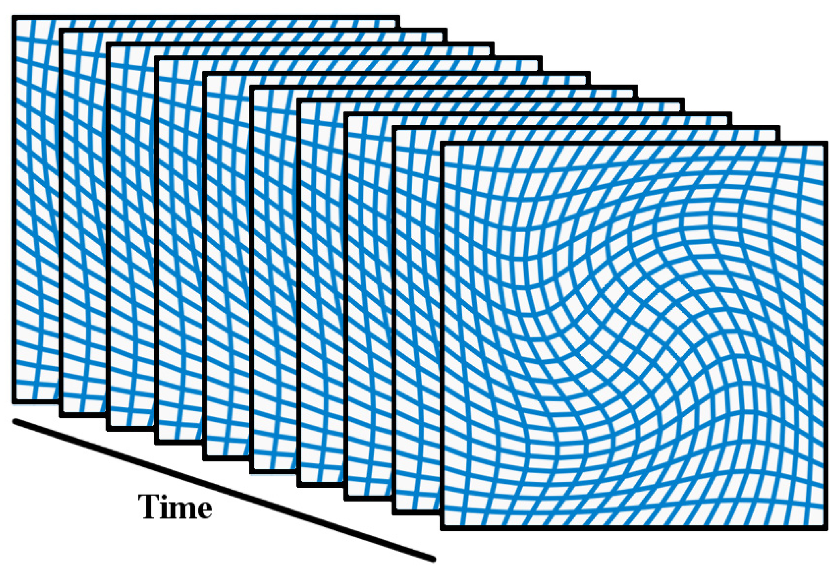
- The evolution of biological tissue is considered as a mechanical system driven by external forces
- Growth trajectories are smooth in both space and time – guaranteed to be twice differentiable
- Our regression model yeilds a shape evolution with improved regularity, discarding more noise from the data to fit a more realistic growth scenario

Method

From discrete shapes to a continuous evolution

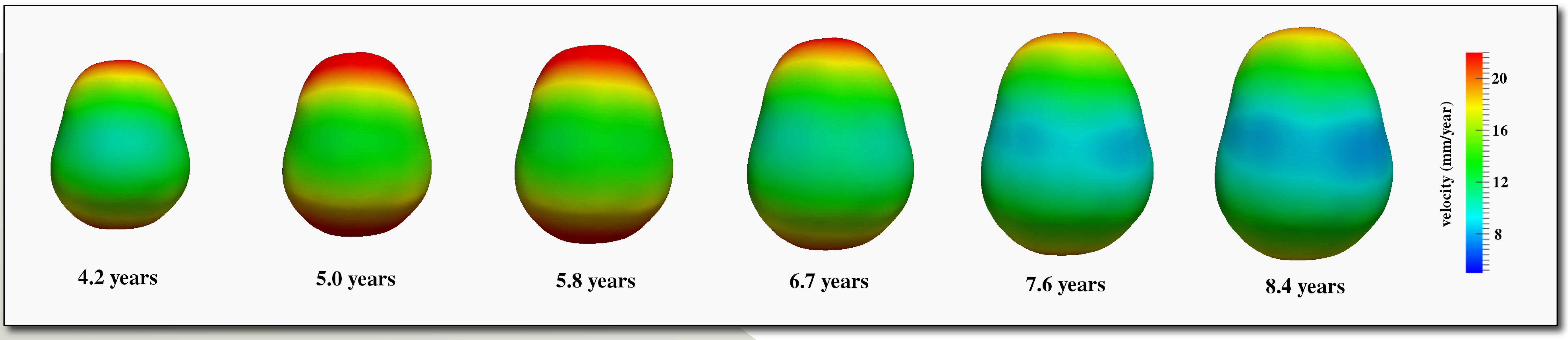


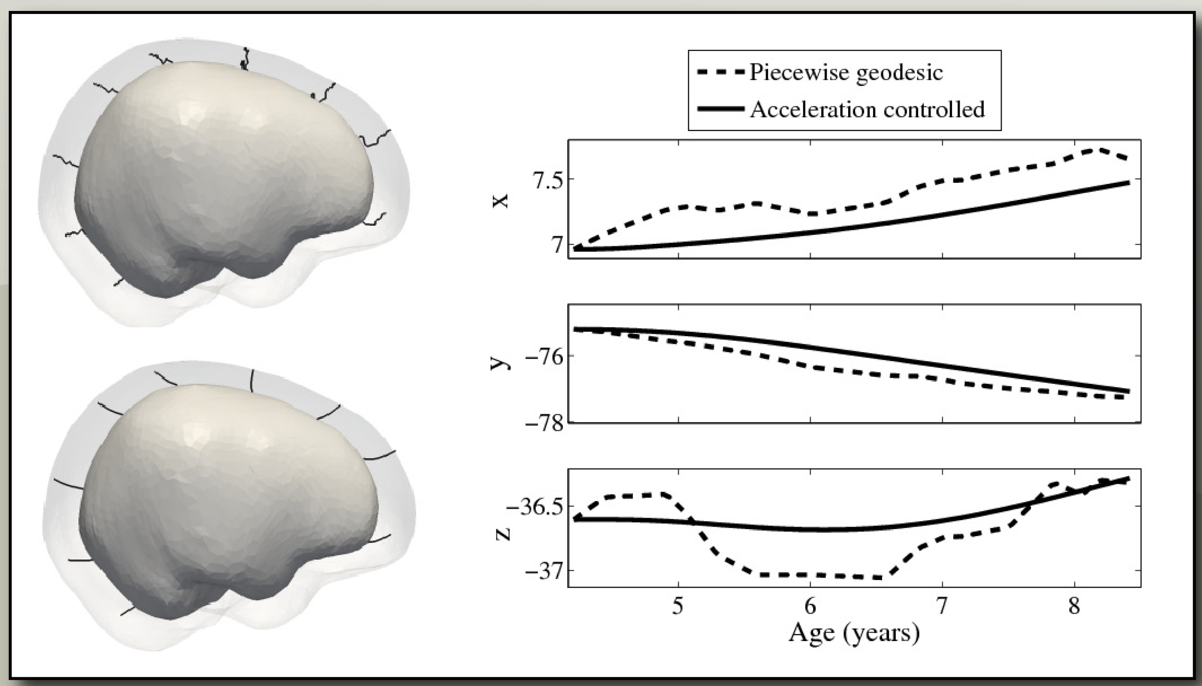
Estimate a continuous deformation of space



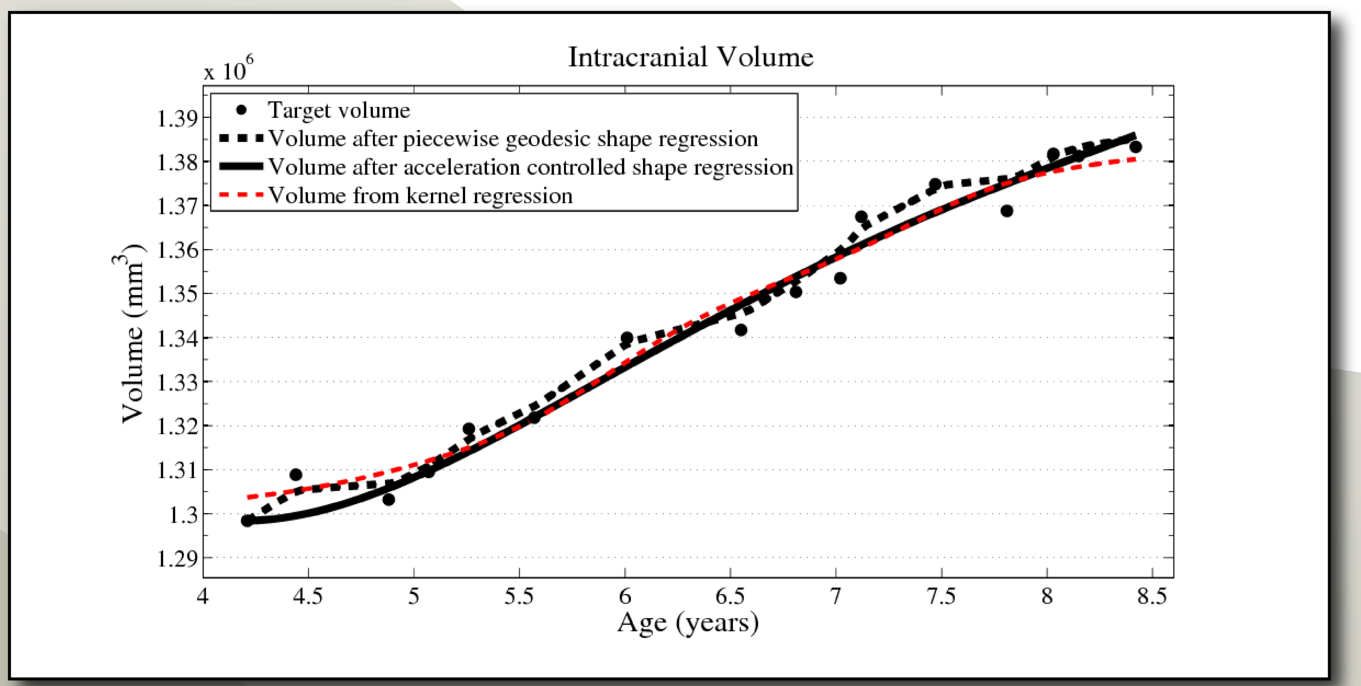
Results

Generate shapes and growth velocity at any instant in time

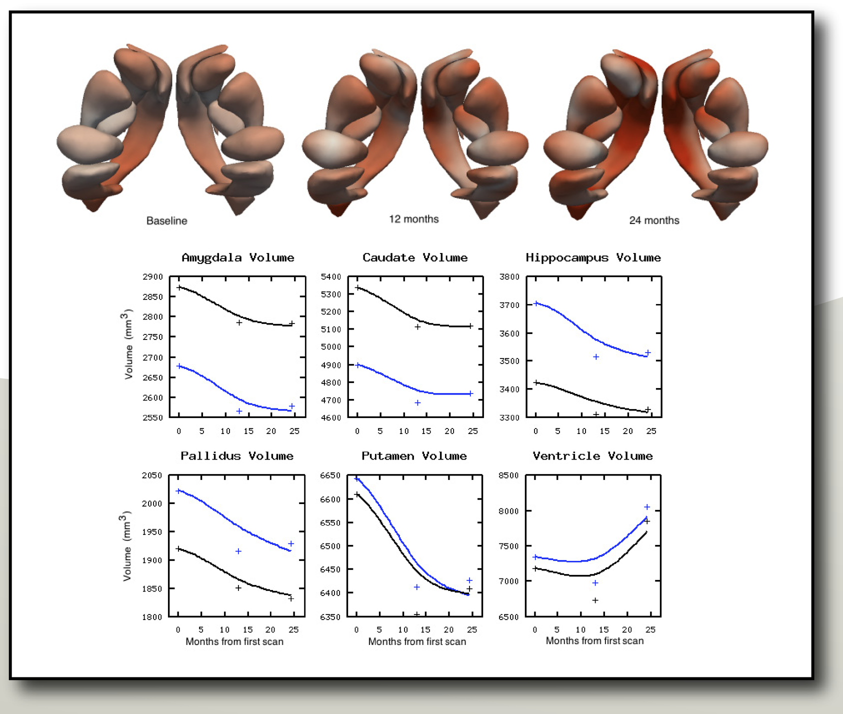




Smoother and more realistic growth trajectories



Evolution of scalar measures extracted from shape regression



Clinical application: Neurodegeneration in Huntington's disease

Conclusion

We have introduced a new 2nd-order regression model for estimating smooth evolution from time dependent shapes. This is based on a new way of parameterizing growth by acceleration rather than velocity. The proposed model is:

- Less sensitive to noise as compared to the standard piecewise geodesic model
- Robust to missing data
- More likely to characterize the underlying biological growth of anatomical structures

Current clinical applications:

- Neurodegenerative pattern in Huntington's disease (HD)
- Atypical brain development in autism

Acknowledgments

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