Travis B. Thompson

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Research Summary

My research develops and analyzes theoretical mathematical models and applies both scientific computing and machine learning to study problems related to the brain, neurological pathology, age-related diseases and complex biological processes on networks with translational emphases in health care and nutritional security.

Academic Appointments

2022-Present **Assistant Professor**, *Texas Tech University*, Dept. of Mathematics and Statistics

2019-2022 **Postdoctoral Research Associate**, *Oxford University*, Mathematical Institute

2017-2019 **Postdoctoral Fellow**, *Simula Research Laboratory*, Dept. of Numerical analysis, and Scientific Computing

2015-2017 **Pfeiffer Postdoctoral Fellow**, *Rice University*, Dept. of Computational and Applied Mathematics

Industrial Appointments

2013-2015 **Software Developer**, *Joint Institute for Computational Sciences at Oak Ridge National Laboratory*

2000-2003 **Software Engineer**, *Integrated Decision Support Corp.*

Education

2007–2013 **Ph.D., Mathematics**, *Texas A&M University*, College Station, TX

2005–2007 **M.Sc., Mathematics**, *The University of Iowa*, Iowa City, IA

2001–2005 **B.Sc., Mathematics**, *The University of Texas, Dallas*, Richardson, TX
Minor in computer science

Research Activity

Publications marked with a * follow the mathematics convention of alphabetical author ordering.

Book Publications

*1 **Mathematical modeling of the human brain: from magnetic resonance images to finite element simulation**, *Mardal K.-A., Rognes M.E., Thompson T.B. and Valnes, L.-M.*, Springer. 2022

Journal Publications

20 **Personalised Regional Modelling Predicts Tau Progression in the Human Brain**, *Chaggar P., Vogel J., Binette, A.-P., Thompson, T., Hansson, O., and Goriely, A. et. al.*, (Submitted, Science Advances), 2023. preprint: doi:10.1101/2023.09.28.559911

19 **The role of clearance in neurodegenerative diseases**, *Brennan G.S., Thompson T.B., Oliveri H., Rognes M.E. and Goriely A.*, SIAM J Appl Math. 0(0): pp S172–S198, 2023. doi:10.1137/22M1487801

18 **Front propagation and arrival times in networks with application to neurodegenerative diseases**, *Putra P., Oliveri H., Thompson T.B. and Goriely A.*, SIAM J Appl Math. 83(1): pp 194–224, 2023. doi:10.1137/21M1467547

*17 **A-posteriori error estimation and adaptivity for multiple-network poroelasticity**, *Eliseussen E., Rognes M.E. and Thompson T.B.*, ESAIM: Math Model Numer Anal. 57(4): pp 1921–1952, 2023. doi:10.1051/m2an/2023033

16 **Brain chains as topological signatures for Alzheimer's disease**, *Goodbrake, C. and Beers, D. and Thompson, T.B. and Harrington, H. and Goriely, A.*, (Submitted), 2022. preprint: arXiv:2208.12748

15 **Predicting brain atrophy from tau pathology: A summary of clinical findings and their translation into personalized models**, *Schäfer A., Chaggar P., Thompson T.B., Goriely A. and Kuhl E.*, Brain Multiphys. 2: pp 100039, 2021. doi:10.1016/j.brain.2021.100039

14 **Braiding Braak and Braak: Staging patterns and model selection in network neurodegeneration**, *Putra P., Thompson T.B. and Goriely, A.*, Network Neurosci. 5(4): pp 929–956, 2021. preprint: doi:10.1162/netn_a_00208

13 **The role of clearance mechanisms in the kinetics of pathological protein aggregation involved in neurodegenerative diseases**, *Thompson T.B., Meisl G., Knowles T. and Goriely A.*, J. Chem. Phys. 154(12): pp 125101, 2021. doi:10.1063/5.0031650

*12 **Accurate Discretization Of Poroelasticity Without Darcy Stability**, *Mardal K.-A., Rognes, M.E. and Thompson, T.*, BIT Numer. Math. 61: pp 941–976, 2021. doi:10.1007/s10543-021-00849-0

11 **Parameter robust preconditioning by congruence for multiple-network poroelasticity**, *Piersanti E., Lee J.J., Thompson T.B., Mardal K.-A. and Rognes M.E.*, SIAM J. Sci. Comput. 43(4): pp B984–B1007., 2021. doi:10.1137/20M1326751

10 **Anisotropic Diffusion and Traveling Waves of Toxic Proteins in Neurodegenerative Diseases**, *Kevrikidis P.G., Thompson T.B. and Goriely A.*, Phys. Rev. Lett. A., 2020. 384(36): pp 126935 doi:10.1016/j.physleta.2020.126935

9 **Protein-protein interactions in neurodegenerative diseases: a conspiracy theory**, *Thompson T.B., Chaggar P., Kuhl E. and Goriely A.*, PLoS Comput. Biol., 2020. 16(10): pp e1008267 doi:10.1371/journal.pcbi.1008267

*8 **An observation on the uniform preconditioners for the mixed Darcy problem**, *Bærland T., Kuchta M., Mardal K.-A. and Thompson T.B.*, Numer. Meth. Part. DE., 2020. 36(6): pp 1718-1734 doi:10.1002/num.22500

7 **An implicit discontinuous Galerkin method for modeling edema in the intestine**, *Thompson T.B., Riviere B. and Knepley M.*, IMA J. Math. Medic. and Biol., 2019. 36(4): pp 513–548. doi:10.1093/imammb/dqz001

*6 **A stable, enriched Galerkin element for the Stokes problem**, *Chaabane N., Girault V., Riviere B., and Thompson T.B.*, Appl. Num. Math., 2018. 132: pp 1-21. doi:10.1016/j.apnum.2018.04.008

*5 **An conservative anti-diffusion technique for the level set method**, *Guermond J.-L., Quezada de Luna M. and Thompson T.B.*, J. Comp. and Appl. Math., 2017. 321: pp 448-468 doi:10.1016/j.cam.2017.02.016

*4 **Error analysis of primal discontinuous Galerkin methods for a mixed formulation of the Biot equations**, *Riviere B., Tan J., and Thompson T.B.*, Comp. and Math. with Appl., 2017. 73(4): pp 666-683 doi:10.1016/j.camwa.2016.12.030

*3 **A discrete commutator theory for the consistency and phase analysis of semi-discrete C^0 finite element approximations to the linear transport equation**, *Thompson T.*, J. Comp. and Appl. Math., 2016. 303: pp 229-248. doi:10.1016/j.cam.2016.02.042

*2 **Validation of an entropy-viscosity model for LES**, *Guermond J.-L., Larios A. and Thompson T.B.*, In: Frohlich J., Kuerten H., Geurts B., Armenio V. (eds) Direct and Large-Eddy Simulation IX. ERCOFTAC Series, vol 20. Springer, 2015. pp 43–48. doi:10.1007/978-3-319-14448-1_6

*1 **Coloring the Mu transpososome**, *Darcy I., Navarra-Madsen J., Thompson T.B. et. al*, BMC Bioinformatics, 2006. 7(435). doi:10.1186/1471-2105-7-435

Selected Talks

15 **University of Maryland, Department of Mathematics. Oct 2023**, *(Invited)*, 'Biomathematics and the Brain'

14 **University of Texas at Arlington, Department of Biomedical Engineering. Sep 2023**, *(Invited)*, 'Neurodegeneration and Neuropathology: mathematical perspectives for the prospective practitioner'

13 **MD Anderson Cancer Center, Department of Imaging Physics. Jan 2023**, *(Invited)*, 'Meshes, methods and modeling: Developing an ecosystem for mathematical neurology'

12 **SIAM TX-LA: Modeling the heart-brain axis and age-related pathology. Nov 2022**, *(Organizer)*, 'Senescence, Sangre, Senility and Simulation: Mathematics at the intersection of the heart and the brain'

11 **SIAM TX-LA: Mathematics and Computation in Biomedicine. Nov 2022**, *(invited)*, 'Mechanistic models of Alzheimer's disease'

10 **BrainNet Workshop. KTH Royal Institute of Technology. May 2022**, *(invited)*, 'Networking neurodegeneration'

9 **18th European Mechanics of Materials Conference. April 2022**, 'Multiphysics models of neurodegenerative disease'

8 **Industrial and Applied Mathematics Colloquium. Mathematical Institute, Oxford. November 2021**, *(invited)*, 'Mathematics of the mind'

7 **Department of Mathematics Colloquium, Texas Tech University. Lubbock, Texas. October 2021**, *(invited)*, 'Bioscientific Computing: Data driven mathematical modeling and analysis of neurological pathology and Alzheimer's disease'

6 **6th Oxford International Neuron and Brain Mechanics Workshop. Oxford, United Kingdom. April 2021**, *(invited)*, 'A model of protein-protein interaction in neurodegeneration with application to Alzheimer's disease'

5 **Interpore 2019. Valencia, Spain. May 2019**, 'Advances in conformal finite element methods for generalized poroelasticity: A-posteriori error estimates for the two-field generalized poroelasticity equations and an elliptic-parabolic framework'

4 **2018 Simula Research Conference. Son, Norway. August 2018**, *(invited)*, 'Waterscape of the Brain: Mathematics and Scientific Computing Enabling Clinical Simulation'

3 **SIAM Life Sciences. Minneapolis, Minnesota. August 2018.**, *(minisymposium organizer)*, 'Stokes-Biot Stability and a Mixed Formulation For Generalized Poroelasticity', Minisymposium: Robust Finite Element Methods With Application To Soft Tissue Biomechanics

2 **ECCM-ECFD. Glasgow, United Kingdom. June 2018.**, 'A Stokes-Biot Stable Hdiv-Based Mixed Method for Generalized Poroelasticity', Minisymposium: Numerical methods for coupled problems involving fluids and solids

1 **FEniCS'18, Oxford, United Kingdom March 2018.**, 'A Robust 3-Field formulation for Generalized Poroelasticity', 2018 FEniCS Workshop and Conference

Current Students

6 **Bradley Vigil**, *Topological methods for network models of brain dynamics*, Ph.D. advisor, Texas Tech University

5 **Robert Young**, *Translational data-driven modeling of glioma treatment*, Undergraduate thesis advisor, Texas Tech University

4 **Andrew O'Heachteirn**, *Multiscale network dynamical models of the cerebral vasculature in neurodegenerative diseases*, D.Phil co-advisor, Oxford University

3 **Georgia Brennan**, *Clearance mechanisms in graph neurodegeneration dynamics*, D.Phil co-advisor, Oxford University

2 **Pavanjit Chaggar**, *Data-driven network models of neurodegeneration*, D.Phil co-advisor, Oxford University

1 **Prama Putra**, *Graph Analysis and staging for network models of infectious proteopathy in the brain*, D.Phil co-advisor, Oxford University

Former Students

4 **Emilie Ødegaard**, *A posteriori error estimates for generalized poroelasticity*, M.Sc.

3 **Kentrell Owens**, *Scientific Computing with FEniCS*, Research intern

2 **James Phillips**, *Mathematical modeling of soft-tissue edema*, Undergraduate thesis

1 **James Lee**, *Data-driven mathematical modeling of edema*, Undergraduate thesis

Teaching and Service

Teaching

F2023-S2024 **Numerical Analysis I, Numerical Analysis II**, *Texas Tech University Graduate*

F2022-S2023 **Numerical Analysis I, Numerical Analysis II**, *Texas Tech University Graduate*

S2015-S2017 **Differential Equations in Science and Engineering**, *Rice University Undergraduate*