Justin Dong

– Providence, RI
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Education

Brown University **Providence, RI**
M.Sc., Applied Mathematics *2019*
Ph.D. Candidate, Applied Mathematics 2023 (expected)

Rice University **Houston, TX**
Bachelor of Arts, Computational and Applied Mathematics *2014*
Bachelor of Science, Mechanical Engineering

- Magna cum laude, distinction in research and creative work

Research Interests

- Scientific machine learning
- High-order accurate numerical methods for PDEs

Publications

- M. Ainsworth and **J. Dong**. *On the Neural Network Approximation of non-Self Adjoint Problems with Low-Regularity Data*. In preparation (2023).
- A. Howard, **J. Dong**, Patel, R., D'Elia, M., P. Stinis, and M. Maxey. *Machine learning methods for particle stress development in suspension Poiseuille flows.* In preparation (2023).
- M. Ainsworth and **J. Dong**. *Galerkin Neural Network Approximation of Multiscale Problems*. Computer Methods in Applied Mathematics and Engineering. Computer Methods in Applied Mechanics and Engineering (2022).
- M. Ainsworth and **J. Dong**. *Galerkin Neural Networks: A Framework for Approximating Variational Equations with Error Control*. SIAM Journal on Scientific Computing **43**(4). A2474-A2501 (2021).
- **J. Dong** and B. Rivère. *A semi-implicit method for incompressible three-phase flow in porous media*. Computational Geosciences **20**(6). 1169-1184 (2016).
- J. Dong. *A high-order method for three-phase flow in homogeneous porous media*. SIAM SIURO Vol. 7, 2014.

Computer skills

Languages: C/C++, MATLAB, Python

API/Library: OpenMP, CUDA, MPI, Tensorflow, Jax

Typesetting: LaTeX

Research & Work Experience

Brown University, Providence, RI **September 2019 – Present**

Graduate Student Researcher

My primary work involves the development of a neural network approach based on learning Riesz representers to the weak residuals of PDEs and synthesizes concepts from both machine learning and traditional Galerkin finite element methods. Applications considered include solid mechanics (Reissner-Mindlin plate approximation) and fluid dynamics (Stokes flow with corner singularities). Advised by Professor Mark Ainsworth.

Pacific Northwest National Laboratory, Richland, WA **May – July 2022**

Research Intern

Developed a neural network approach for learning closures of monodisperse and bidisperse suspension flows. Produced high-resolution approximations of several proposed suspension balance models using neural networks (both Galerkin neural networks and physics-informed neural networks (PINNs) approaches) and analyzed the various models's efficacies in capturing particle scale dynamics. Advised by Dr. Amanda Howard.

Lawrence Livermore National Laboratory, Livermore, CA **May – July 2018**

Research Intern

Implemented a 2D solver for Maxwell's equation using a nodal discontinuous Galerkin finite element method on GPUs. Integrated the solver with RAJA – a software abstraction layer for `C++` enabling architecture portability for HPC applications – and mint – a mesh generation package. Advised by Dr. Arturo Vargas.

Metro ElderCare Agency, Massapequa, NY **February 2016 – June 2017**

Administrative Assistant

Assisted clients in applying for nursing home and homecare Medicaid in New York State. Worked with clients to ensure they were/remained financially eligible for Medicaid. Liaised with New York State Department of Health on behalf of clients to ensure all requests for information were completed in a timely manner.

University of Stuttgart, Germany **March – August 2015**

Visiting Research Scholar

Implemented a discontinuous Galerkin finite element method for two-phase flow in heterogeneous media with discontinuous capillary pressures, with particular attention given to interface conditions at the media boundaries. Research funded by Rice University's Wagoner fellowship. Advised by Professor Rainer Helmig.

Rice University, Houston, TX **Jan 2013 – May 2014**

Undergraduate Research Assistant

Developed a semi-implicit discontinuous Galerkin finite element spatial discretization for three-phase flow in porous media and carried out simulations in highly heterogeneous media using data from the SPE10 dataset. This work was published in *Computational Geosciences* in 2016. Advised by Professor Béatrice Rivière.

ETH Zürich, Switzerland **May 2013 – July 2013**

Research Intern

Carried out the implementation of an $H(\text{curl})$-conforming discontinuous finite element method as well as implementation of an auxiliary subspace preconditioner for Maxwell's equations in MATLAB. Research funded by the ThinkSwiss fellowship.

Presentations

- Talk: *Galerkin Neural Network Approximation of Multiscale Problems*. SIAM Mathematics of Data Science, 2022.

- Talk: *Galerkin Neural Networks: A Framework for Approximating Variational Equations with Error Control*. SIAM Annual Meeting, 2021.
- Poster: *A High-Order Method for Incompressible Three-Phase Flow in Heterogeneous Porous Media*. SIAM Annual Meeting, 2014.

Honors & Awards

National Science Foundation Graduate Research Fellowship — March 2018

National Defense Science and Engineering Graduate Fellowship (declined) — April 2018

Teaching Experience

- CECS 0915 (Brown University Pre-College): Artificial Intelligence: Modeling Human Intelligence with Networks, instructor (Summer 2021). Developed all course materials, gave lectures, managed teaching assistants, and held office hours for a class of 30 students.
- Applied Mathematics 340: Methods of Applied Mathematics II, head teaching assistant (Spring 2019)
- Applied Mathematics 330: Methods of Applied Mathematics I, head teaching assistant (Fall 2018)

Mentoring Experience

- Simran Nayak (undergraduate): supervised an independent reading project in adaptive finite element methods for differential equations in one dimension (Fall 2018)
- Daniel Masotti (undergraduate): supervised an independent reading project in preconditioned Krylov subspace methods for large-scale linear systems of equations - ongoing (Spring 2019)
- Emily Reed (undergraduate): supervised an independent reading project in artificial neural networks (Fall 2019)
- Sam Chowning & Arturo Ortiz San Miguel: supervised an independent reading project on singular value decomposition and its applications (Fall 2020)

Outreach & Service

Applied Math Directed Reading Program — **Aug 2018 – 2022**

Founder & Organizer

In Fall 2018, I founded the Department of Applied Mathematics's Directed Reading Program at Brown University, which allows advanced undergraduates to work one-on-one with graduate student mentors on independent reading projects. Some testimonials from undergraduates:

- "The mentorship I received was valuable both as an opportunity to hear first-hand mathematical expertise from a mentor as well as learn more about experiences from a female mentor in the math community."
- "[The DRP was] a great way to get interested undergraduates their first exposure to doing research and. . . begin to dive into a topic they can't just study in a more general class."

Faculty Graduate Liason **Aug 2018 – 2021**

Division of Applied Mathematics, Brown University

I present budget requests from student organizations in the department to the department chair and convey concerns of graduate students to faculty.

Applied Math Graduate/Undergraduate Mentorship Program **Jan 2018 – Present**

Organizer

The Graduate/Undergraduate Mentorship Program allows undergraduate applied math concentrators at Brown to receive one-on-one advising from graduate students. The program is geared towards undergraduates planning to go to graduate school or those who simply seek an extra avenue of advising beyond their faculty advisor.