

Yue Liu

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Academic Interests

- Mechanistic modelling of biological and physical systems with partial differential equations (PDEs) and dynamical systems
- Numerical simulations, asymptotic analysis, bifurcation and dynamical behaviors of PDEs
- Application of machine learning toward biological data

Technical Skills

- Proficient in: Java, C, C++, Python, Matlab, Julia, Scheme/Racket.
- Intermediate experience with: R, Perl, JavaScript, PHP
- Familiar with object-oriented and functional programming paradigms
- Knowledge of databases and experienced with SQL
- Familiar with Linux operating system and capable of writing Bash scripts
- Familiar with version control: Git, SVN, Mercurial

Education

University of Oxford <i>Doctor of Philosophy</i> Mathematics, focus on PDE and statistical modelling of biological systems. Supervised by Prof. Ruth Baker	Oxford, UK 2019–present
University of British Columbia <i>Master of Science</i> Applied Mathematics, focus on mathematical modelling and analysis of biological systems. Graduating average 93.2% (A+). Supervised by Prof. Leah Edelstein-Keshet	Vancouver, BC, Canada 2017–2019
University of Waterloo <i>Bachelor of Mathematics (Honours, Co-op)</i> Double major in Computer Science and Mathematical Physics, minor Pure Mathematics, Graduated with overall average 95.5% and With Distinction – Dean’s Honours List	Waterloo, ON, Canada 2012–2017
Fort Richmond Collegiate <i>High school</i> Graduated with Magna Cum Laude, final average 98%	Winnipeg, MB, Canada 2009–2012

Selected Awards and Scholarships

- Canada Postgraduate Scholarships – Doctoral (PGS-D), 2019. Awarded by Natural Sciences and Engineering Research Council (NSERC), \$63,000
- Canada Graduate Scholarships-Master’s (CGS-M), 2017. Awarded by Natural Sciences and Engineering Research Council (NSERC), \$17,500
- R Howard Webster Foundation Fellowship, 2017. University of British Columbia (UBC), \$2,500

- Faculty of Science Graduate Award, 2017-2018. UBC, \$5,500
- Lloyd Switzer Scholarship in Applied Mathematics, 2017. University of Waterloo (UW), \$2,500
- Arthur Beaumont Memorial Scholarship, 2016. UW, \$2,000
- Frank Goodman Memorial Scholarship, 2015. UW, \$2,000
- University of Waterloo Descartes National Scholarship, 2012-2016. UW, \$12,000

Publications

Andreas Buttenschön, **Yue Liu**, and Leah Edelstein-Keshet. Cell size, mechanical tension, and gtpase signaling in the single cell. *Bulletin of Mathematical Biology*, submitted Aug 2019, in revision.

Yue Liu, Elisabeth G. Rens, and Leah Edelstein-Keshet. Spots, strips, and spiral waves in models for static and motile cells. submitted Sept 2019, in preparation.

Yue Liu, John Milton, and Sue Ann Campbell. Outgrowing seizures in childhood absence epilepsy: time delays and bistability. *Journal of computational neuroscience*, 46(2):197–209, 2019.

Priyank Jaini, Abdullah Rashwan, Han Zhao, **Yue Liu**, Ershad Banijamali, Zhitang Chen, and Pascal Poupart. Online algorithms for sum-product networks with continuous variables. In *Conference on Probabilistic Graphical Models*, pages 228–239, 2016. proceedings.mlr.press/v52/jaini16.pdf.

Research Experience

University of Waterloo

USRA Undergraduate Researcher

Developed and analyzed delay differential equation models for the three neuron motif consisting of cortical, thalamic relay, and reticular nuclei neurons. Simulated the system with XPPAUT. Interpreted the result and its significance with respect to childhood absence epilepsy (CAE). Supervised by Prof. Sue A. Campbell.

Waterloo, ON, Canada

January–August 2017

Agriculture and Agri-Food Canada

Bioinformatics Software Developer

Developed the Genomics and Transcriptomics Analysis pipeline. Utilized bioinformatics softwares to analyze the fungi *Penicillium verrucosum*. Integrated bioinformatics softwares into the Galaxy environment. Supported research projects on genomics under Dr. K. Seifert.

Ottawa, ON, Canada

May–August 2014

Teaching Experience

University of Oxford

Teaching Assistant

Oxford, UK

October 2019–Present

University of British Columbia

EDUCE Teaching Assistant

Responsible for developing curriculum and delivering data science workshops for the Experiential Data science for Undergraduate Cross-disciplinary Education (EDUCE) program.

Vancouver, BC Canada

September 2018–April 2019

University of British Columbia

Math Graduate Teaching Assistant

Taught workshop sessions for MATH 180 (Calculus 1). Graded assignments and exams for courses MATH 256 (Calculus 3), 221 (Linear algebra). Tutored students in the Math Learning Center.

Vancouver, BC Canada

September 2017–December 2018

Industry Experience

Facebook, Inc.

Software Engineer (intern)

Menlo Park, CA, USA

May–August 2016

Worked on core growth team. Implemented new non-relational database scheme and read/write interface for efficient storage of records. Developed new machine learning model for messaging inactive users, which improved user retention by up to 14%.

Amazon Web Services

Software Development Engineering (intern)

Seattle, WA, USA

September–December 2015

Worked on the Amazon API Gateway team. Developed fully automated integration testing framework and test suites for the SDK generation feature. Identified defects in the program and proposed ways of improvements.

NexJ Systems Inc.

Quality Assurance Analyst (intern)

Toronto, ON, Canada

May–August 2013

Identified bugs in software products and helped fixing them. Created test plans for new software features. Proposed new features and their high level implementation.

Selected Projects

- **Masters Project:** *'Extensions of the wave-pinning model and applications to cellular mobility'*
Cellular polarization is essential for a variety of cell behaviors. This project studies two extensions to the wave-pinning model proposed by Mori et al (2008), which describes the dynamics of regulatory proteins in a cell. The model is analyzed numerically, and its bifurcation and asymptotic properties are explored. Finally, I relate the results to experimental observations and interpret its biological significance in real cells.
- **Perturbation Methods for PDEs course project:** *'Stability analysis for spikes solutions to the Gierer-Meinhardt model'*
This project follows the analysis of Iron, Ward & Wei (2001) and analyze the existence and stability of multi-spike solutions to the Gierer-Meinhardt model using perturbation methods and non-local eigenvalue analysis.
- **Advanced Dynamical Systems course project:** *'Dynamical systems description of the Wave Pinning model'*
This project uses local perturbation analysis to examine the wave-pinning model by Mori et al (2008), and focuses on the analysis of codimension-two bifurcations.
- **BC Data Science Workshop 2018 project:** *'A Deep Look into Cytokines and Septic Shock'*
We analyzed genetic and cytokine data from patient records from the VASST study. We identified the relationship between SNPs (single nucleotide polymorphisms), cytokines and sepsis survival with statistical and machine learning techniques. This was done in collaboration with St. Paul's hospital.
- **PIMS Industrial Problem Solving Workshop 2018 project:** *'AI for Tactical Asset Allocation'*
We were interested in the relation between certain economic indicators and relatively return of different types of financial assets. I adapted several standard machine learning techniques to finance application. We found it is difficult to beat relatively simple strategies, however ensemble learning can yield strategies with lower volatility.
- **Mathematical Biology course project:** *'Dynamics of Evolutionary Game Theory and Application Toward Animal Conflict Behaviors'*
The project extends the work done by Smith & Price (1973) on explaining why animals do not always

use the most effective combat strategies during mating competitions. My work extends the model by considering the fitness of strategies in a more realistic environment, with non-equilibrium dynamics and stochastic effects.

- **Industrial Mathematics course project:** *'Examining behaviors of periodically-forced predator-prey system with Floquet theory'*

This project follows the work of Moghadas & Alexander (2005). I examined the dynamics of a predator-prey model with seasonally-varying forcing term. A rich variety of behaviors, including bifurcations, period doubling cascade and emergence of chaos were analyzed with Floquet theory and Poincaré maps.

- **Advanced Machine Learning course project:** *'Solving Partial Differential Equations with Artificial Neural Networks'*

We were interested in evaluating various proposed artificial neural network-based PDE solvers against traditional solvers, and how they compare to their theoretical optimal performance. We implemented one such solver in Julia, and found that while it works satisfactorily, it has higher errors than both FDM, FEM solvers and theoretical optimum. Despite this, it has advantages such as highly parallelizable, and provides an analytical solution.

- **USRA research project:** *'Examining Childhood Absence Epilepsy Through Conductance-based Delay Differential Equation Models'*

We modelled a small neuron network with a conductance-based model and delay differential equations. We numerically explored its behaviors and found bistability that occur only in certain parameter regimes. We associate bistability with epileptic seizure, and explain the role of neural conductance delay and genetic defect on the onset and recovery of childhood absence epilepsy.

- **Fluid Dynamics course project:** *'Analysis of Tsunami waves with shallow water equations'*

I analyzed the shoaling of Tsunami waves (the phenomenon that the waves grow drastically in height) with shallow water equations and obtain analytical solutions for the case of straight slope using "hodograph transformation" proposed by Aydin & Kanoglu (2012). I then numerically simulate the Tsunami and provide a physical explanation by analyzing energy. Finally, I use wave tank experiments to reveal shortcomings of the theoretical results.

- **Undergrad research project:** *'Empirical Evaluation of Stacked Restricted Boltzmann Machine'*

In this project, I implemented stacked-restricted Boltzmann machine (SRBM) and applied it to several datasets from the UCI machine learning repository in order to evaluate its performances. This was a part of a larger project to propose an online algorithm for training sum-product networks.

- **Quantum Computing course project:** *'Quantum Adversary Method for Proving Lower Bound of Quantum Query Complexity'*

This project studied the quantum adversary method proposed by Ambainis (2000), its application toward proving lower bounds for the unordered search problem, and its consequences.

Selected Conferences and Workshop participation

Delivered oral and/or poster presentations on various topics:

- **Canadian Applied and Industrial Mathematics Society Annual Meeting**, Whistler, Canada, June 2019
- **SIAM Conference on Applications of Dynamical Systems**, Snowbird, Utah, USA, May 2019
- **Canadian Mathematical Society Winter Meeting**, Vancouver, Canada, Dec. 2018
- **PIMS Workshop on Stochastic and Deterministic Modelling in Biology**, Jasper, Canada,

Sept.2018

- **PIMS Industrial Problem Solving Workshop**, U of Calgary, Canada, August 2018
- **Mechanobiology Symposium: The Mechanome in Action**, UC Irvine, USA, July 2018
- **BC Data Science Workshop**, UBC, Canada, June 2018
- **Biophysical Society of Canada Annual Meeting**, Simon Fraser University, Canada, May 2018
- **Canadian Undergraduate Mathematics Conference**, Montreal, Canada, July 2017
- **Undergraduate Applied Mathematics Conference**, University of Western Ontario, Canada, March 2017