

PERSONAL
INFORMATION

Martin Magill
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I am a PhD candidate under the supervision of Dr. Hendrick de Haan at the University of Ontario Institute of Technology (UOIT). My primary research interest is in the use of deep neural networks to solve differential equations. This method works on high-dimensional problems, where traditional approaches fail. I am applying it to my research in nanobiophysics, to augment particle-based simulations of polymers in nanofluidic devices, as well as to directly solve the high-dimensional differential equations that describe stochastic many-body systems. I also conduct theoretical deep learning research on these networks, which provide unique opportunities for studying concepts such as generalization, interpretation, visualization, and sparsification.

EDUCATION

Master's degree in modelling and computational science from the University of Ontario Institute of Technology (2014-2016). Thesis advisors: Ed Waller and Hendrick W. de Haan. Thesis title: *Characterization of Nanopores With Internal Cavities for DNA Manipulation Using Langevin Dynamics Simulations.*

Bachelor's degree in mathematics from the University of Waterloo (2009-2014). This program included six co-op work terms including three work reports, two of which were nominated for awards.

JOB EXPERIENCES

2014 September → Present (UOIT) Teaching assistant at the University of Ontario Institute of Technology. I have been a teaching assistant for various undergraduate courses, where my responsibilities included preparing and delivering lectures, tutorials, and evaluations to classes of ten to forty students at a time.

2014 May → August (University of Waterloo) Created a 2D pseudo-spectral numerical solver for the magnetohydrodynamic shallow-water equations, and used it to study wave propagation in the solar tachocline. Wrote a coupled 2D-3D iterative pseudo-spectral numerical solver to reproduce the normal field instability in ferrofluids, and constructed an experimental demonstration.

2013 May → August (Atomic Energy of Canada Limited) Worked extensively with the Serpent Monte Carlo reactor physics burnup calculation code. Conducted and documented validations of new code releases. Simulated lattice and full-core models of the CANDU, ZED-2, CANFLEX, SCWR, and EFR reactors.

2012 September → December (GRRCC) Worked as a physics technician at the Grand River Regional Cancer Centre. Maintained linear accelerators used for cancer treatment. Created a GUI for analysing radiation treatment plans.

2012 January → April (HC RPB) Worked as a research assistant at the Health Canada Radiation Protection Bureau. Applied machine learning to Geant4 models of the CRIPT detector. Maintained a local Linux-based computing cluster.

2011 January → August (SNOLAB) Worked on the disassembly, reassembly, and operation of the DEAP-1 dark matter experiment. Designed passive calibration techniques for the DEAP-3600 experiment using Monte Carlo simulations.

2010 May → August (Deep River Science Academy) Optimized fuel bundle designs for the SCWR reactor. Taught and supervised high school students.

2009 July → August (Atomic Energy of Canada Limited) Simulated advanced reactor fuel designs in various reactor conditions.

2008 September → 2009 January (Atomic Energy of Canada Limited) Modelled the flow of nuclear reactor waste in advanced fuel cycles.

PUBLICATIONS
(PUBLISHED)

Magill, M., A. Coutino, B. A. Storer, F. Poulin, M. Stastna. *Dynamics of nonlinear Alfvén waves in the shallow water magnetohydrodynamic equations*. Physical Review Fluids (2019).

Magill, M., F. Z. Qureshi, and H. W. de Haan. *Neural Networks Trained to Solve Differential Equations Learn General Representations*. Advances in Neural Information Processing Systems (2018).

Magill, M., E. Waller, H. W. de Haan. *A sequential nanopore-channel device for polymer separation*. The Journal of Chemical Physics (2018).

Briggs, K., G. Madejski, **M. Magill**, K. Kastritis, H. W. de Haan, J. L. McGrath, and V. Tabard-Cossa. *DNA Translocations Through Nanopores Under Nanoscale Pre-Confinement*. Nano Letters (2017). Also accepted as the cover article.

Magill, M., C. Falconer, E. Waller, and H. W. de Haan. *Translocation Time through a Nanopore with an Internal Cavity Is Minimal for Polymers of Intermediate Length*. Physical Review Letters (2016).

Stocki, T. J., C. Warren, **M. P. C. Magill**, B. E. Morgan, J. Smith, D. Ong, V. N. P. Anghel et al. *Machine learning for the cosmic ray inspection and passive tomography project (CRIPT)*. Nuclear Science Symposium and Medical Imaging Conference (2012).

Magill, M., J. Pencer, R. Pratt, W. Young, G. W. R. Edwards, and B. Hyland. *Thorium fuel cycles in the CANDU supercritical water reactor*. 5th International Symposium on Supercritical-Water-Cooled Reactors (2011).

Hyland, B., E. D. Collins, R. J. Ellis, G. Del Cul, and **M. Magill**. *Transmutation of americium in a lanthanide matrix*. GLOBAL 2011 congress.

Hyland, B., G. R. Dyck, G. W. R. Edwards, and **M. Magill**. *Homogeneous thorium fuel cycles in CANDU reactors*. GLOBAL 2009 congress.

PUBLICATIONS
(IN PROGRESS)

Lam, M., K. Briggs, K. Kastritis, **M. Magill**, G. Madejski, J. McGrath, H. W. de Haan, V. Tabard-Cossa. *Entropic Trapping of DNA with a Nanofiltered Nanopore*. Submitted to ACS Applied Nano Materials in February 2019.

Magill, M., A. Nagel, and H. W. de Haan. *Solving Laplace's Equation in Complicated Geometries with Deep Learning*.

Nagel, A., **M. Magill**, and H. W. de Haan. *Solving First Passage Processes in Complicated Geometries with Deep Learning*.

Drossis, N., **M. Magill**, and H. W. de Haan. *Sorting Nanoparticles by Radius using a Nanopore with an Internal Cavity*.

Kastritis, K., **M. Magill**, and H. W. de Haan. *Diffusion-Limited Dynamics of Semi-flexible Polymer Translocation with Capture*.

CONFERENCE
PRESENTATIONS
(ORAL)

2019 May 2 Graduate Student Council Conference at UOIT. *Deep Learning for Solving Differential Equations*. M. Magill, A. Nagel, F. Z. Qureshi, H. W. de Haan.

2019 March 5 March Meeting of the American Physical Society. *Data-Free Deep Neural Networks for Solving Partial Differential Equations in Nanobiophysics*. **Magill, M.**, A. Nagel, and H. W. de Haan.

2018 June 2 Graduate Student Council Conference at UOIT. *Teaching Neural Networks to Solve Differential Equations*. M. Magill, F. Z. Qureshi, H. W. de Haan.

2017 June 16 ONE Biophysics at the University of Toronto Mississauga. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by*

Nanochannels. M. Magill, E. Waller, H. W. de Haan.

2017 May 6 Chemical Biophysics Symposium at the University of Toronto. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by Nanochannels*. M. Magill, E. Waller, H. W. de Haan.

2016 June 15 Canadian Association of Physicists Annual Meeting at the University of Ottawa. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. M. Magill, C. Falconer, E. Waller, H. W. de Haan.

2016 May 5 Graduate Student Council Conference at UOIT. *Novel Nanopores: Entropic Trapping in Polymer Filters*. M. Magill.

2015 April 28 Graduate Student Council Conference at UOIT. *Recoil Energy in Beta Decay*. M. Magill.

CONFERENCE
PRESENTATIONS
(POSTER)

2019 February 22 Vector Research Symposium. *Deep learning for Laplace's equation in a challenging domain*. Magill, M., F. Z. Qureshi, and H. W. de Haan.

2018 December 7 NeurIPS workshop on Compact Deep Neural Network Representation (CDNNRIA). *Compact Neural Network Solutions to Laplace's Equation in a Nanofluidic Device*. Magill, M., F. Z. Qureshi, and H. W. de Haan.

2018 December 4 Conference on Neural Information Processing Systems (NeurIPS). *Neural Networks Trained to Solve Differential Equations Learn General Representations*. Magill, M., F. Z. Qureshi, and H. W. de Haan.

2018 July 25 Deep Learning and Reinforcement Learning Summer School at the Vector Institute. *Neural Networks Trained to Solve Differential Equations Learn General Representations*. M. Magill, F. Z. Qureshi, H. W. de Haan.

2018 June 15 ONE Biophysics at the University of Toronto Mississauga. *Using Neural Networks to Solve Electric Fields in Slit-Well Nanofluidic Devices for Simulations of Nanoparticle Electrophoresis*. M. Magill, E. Waller, H. W. de Haan.

2018 May 5 Chemical Biophysics Symposium at the University of Toronto. *Using Neural Networks to Solve Electric Fields in Slit-Well Nanofluidic Devices for Simulations of Nanoparticle Electrophoresis*. M. Magill, F. Z. Qureshi, H. W. de Haan.

2017 May 25 Biophysical Society of Canada Annual Meeting at l'Université du Québec à Montreal. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by Nanochannels*. M. Magill, E. Waller, H. W. de Haan.

2016 November 11 Nano Ontario Conference by the University of Guelph. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. M. Magill, E. Waller, H. W. de Haan.

2016 May 14 Chemical Biophysics Symposium at the University of Toronto. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. M. Magill, E. Waller, H. W. de Haan.

2015 June 18 Biophysical Society of Canada Annual Meeting at the University of Waterloo. *Nanopores With Internal Cavities as Band-Pass Filters for Polymer Length*. M. Magill, E. Waller, H. W. de Haan.

2015 April 11 Chemical Biophysics Symposium at the University of Toronto. *Radiology of the Beta Decay Recoil Nucleus*. M. Magill, E. Waller, H. W. de Haan.

2014 December 15 University Network of Excellence in Nuclear Engineering Meeting in Mississauga, ON. *Recoil Energy in Beta Decay*. M. Magill, E. Waller, H. W. de Haan.

INVITED TALKS

2019 March 12 Guest lecture at the University of Guelph on *Modelling Convection-Diffusion Processes with Particles and Partial Differential Equations*.

2018 November 27 Invited talk at the University of Waterloo on *What exactly do neural networks learn when they learn to solve PDEs?*

AWARDS AND
AFFILIATIONS

2019 Accepted into the Vector Institute Postgraduate Affiliate Program
2015-19 Ontario Graduate Scholarship, University of Ontario Institute of Technology
2017 Nominated for UOIT Outstanding Thesis Award
2017 Dean's Graduate Scholarship
2017 Graduate Admission Scholarship
2014 Undergraduate Student Research Award, University of Waterloo
2013 Arthur Beaumont Memorial Scholarship, University of Waterloo
2009 President's Scholarship of Distinction, University of Waterloo
2009 Governor General's Award, Mackenzie High School
2009 Millenium Excellence Award, Canada Millenium Foundation

COMPUTER SKILLS

Programming, scripting and markup languages Python and Bash (daily). C, L^AT_EX, tcl (Often). Matlab, C++ (seldomly).
Simulation codes and software packages TensorFlow, Keras (neural networks). ESPResSo, HOOMD-blue (molecular dynamics). FEniCS (finite element). Serpent, MCNP, Geant4, RAT (radiation Monte Carlo). WIMS (nuclear reactor criticality). Weka (machine learning).

LANGUAGE SKILLS

I was raised bilingual in English and French, although my scientific work has been conducted predominantly in English. **English:** Native tongue. **French:** Fluent.