TREVOR VINCENT, PHD

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HIGHLIGHTS

Independent problem solver and researcher with lots of experience presenting scientific work (20+ presentations) and communicating to audiences of different expertise. Currently working on multiple novel projects in the field of machine learning and artificial intelligence.

Experienced C++,C and python programmer (over 100,000 lines+ in each) with expert-level knowledge in numerical solution techniques for partial differential equations and a broad knowledge of machine learning algorithms.

Two years of experience working with a Nobel-prize winning scientific collaboration (LIGO; ligo.org), analyzing time series data and writing simulation software.

Four years of experience working with a team of 10+ programmers developing a next-generation code for upcoming exa-scale supercomputers.

Chess master (title earned in 2008). Former Manitoba chess champion (six consecutive times) and former Canadian scholastic chess champion.

CURRENT PROJECTS

Preconditioning Gradient Descent   Nov. 2019 - Now

· Speeding up NN learning is a very important.
· One method for speeding up the learning rate is by preconditioning gradient descent
· e.g. https://arxiv.org/abs/1902.02257
· With my knowledge of numerical solution methods for elliptic partial differential equations, I have gained a large expertise in preconditioning methods. I am now working on novel preconditioning methods to speed up learning rates for NNs.

Adversarial Attacks on Neural Networks   July 2019 - Now

· Neural Networks and other machine-learning models are vulnerable to adversarial attacks.
· I've developed a gradient-free genetic algorithm based on https://arxiv.org/abs/1805.11090 to find vulnerabilities in black-box machine-learning models.

Chess Puzzle Composition using GANs   Aug. 2019 - Now

· Composing aesthetic chess puzzles is a difficult problem in the field of computer creativity.
· No one has tried composing chess puzzles using a machine learning approach.
· I'm working on a code called DeepChessComposer which currently uses an autoencoder ("Pos2Vec") trained on a large database of chess positions and a Generative Adversarial Network to compose chess puzzles.

N-player No-Limit Texas Holdem Poker using ML approaches   Sept. 2019 - Now

· Machine-learning approaches have shown great promise for heads-up (two-player) no-limit poker (e.g. DeepStack).
· No work has been done to try and extend these 2-player machine learning approaches to 6 or 9-player No-Limit Hold-em Poker (or the general case of N-players).
· I'm currently working on an N-player extension to the two-player Texas Holdem engine DeepStack (https://www.deepstack.ai/).

EXPERIENCE

Canadian Institute for Theoretical Astrophysics
PhD Researcher in Computational Astrophysics

Sept. 2013 - Aug. 2019

· Developed next generation numerical methods for solving the Einstein field equations (a non-linear set of partial differential equations) on supercomputers and implemented them in a $\sim$ 200,000-line code available on GitHub.

· Worked on a team (10+developers) to develop a task-based parallelism framework for numerical relativity called SpECTRE, available on GitHub.

· Member of the LIGO collaboration, working on extracting neutrino and matter emission properties from gravitational wave and electromagnetic counterpart signals of binary neutron star mergers.

University of Winnipeg
Summer Research Scientist

2009-2013

· Developed a state-of-art GPU-accelerated (via CUDA) C++ code for the diffusion and collision of water molecules around randomly oriented axons in 3d brain-matter. This was coupled with a numerical solve of the Bloch partial differential equations to obtain the magnetic resonance imaging signal in realistic environments.

· Developed a Markov chain Monte Carlo code for estimating axon distribution properties from magnetic resonance imaging signals signals.

· Used machine learning techniques to study brain changes in mice with different Alzheimer-based gene modifications.

EDUCATION

University of Toronto, Toronto, ON
Sept. 2013 - August 2019

PhD in Physics, specializing in computational astrophysics. PhD work was funded by an NSERC CGSD scholarship ($105,000) and a NSERC CGSM scholarship ($30,000).
Advisor: Prof. Harald Pfeiffer

University of Winnipeg, Winnipeg, MB
Sept 2008 - Sept 2013

Bachelors of Science in Physics. Undergraduate work was funded by 15 scholarships. Winner of the Governor Generals Silver Medal for highest graduating GPA in the university.

SKILLS

Highly Proficient	C++, C, MPI, CUDA, Bash, Git, CMake, Emacs, GDB, LaTeX
	Python (Pandas, Matplotlib, scikit-learn, tensorflow, keras, etc)
Substantial Experience	OpenCL, Matlab, Mathematica, HDF5, Paraview, Visit,
	SQL, HTML, OpenMP, TravisCI, Jenkins
Working Knowledge	Java, Fortran, Hadoop, Spark

PUBLICATIONS

Vincent, Trevor, Harald P. Pfeiffer, and Nils L. Fischer. "hp-adaptive discontinuous Galerkin solver for elliptic equations in numerical relativity." Physical Review D 100, no. 8 (2019): 084052. arXiv preprint arXiv:1907.01572.

Vincent, Trevor, Francois Foucart, Matthew D. Duez, Roland Haas, Lawrence E. Kidder, Harald P. Pfeiffer, and Mark A. Scheel. "Unequal Mass Binary Neutron Star Simulations with Neutrino Transport: Ejecta and Neutrino Emission." arXiv preprint arXiv:1908.00655. Submitted to Physical Review D. (2019).

Hinderer, Tanja, Samaya Nissanke, Francois Foucart, Kenta Hotokezaka, Trevor Vincent, Mansi Kasliwal, Patricia Schmidt et al. "Distinguishing the nature of comparable-mass neutron star binary systems with multimessenger observations: GW170817 case study." Physical Review D 100, no. 6 (2019): 063021. arXiv preprint arXiv:1808.03836.

Kidder, Lawrence E., Scott E. Field, Francois Foucart, Erik Schnetter, Saul A. Teukolsky, Andy Bohn, Trevor Vincent et al. "SpECTRE: A task-based discontinuous Galerkin code for relativistic astrophysics." Journal of Computational Physics 335 (2017): 84-114.

Mercredi, Morgan, Trevor J. Vincent, Christopher P. Bidinosti, and Melanie Martin. "Assessing the accuracy of using oscillating gradient spin echo sequences with AxCaliber to infer micron-sized axon diameters." Magnetic Resonance Materials in Physics, Biology and Medicine 30, no. 1 (2017): 1-14.

Hayes, Kerrie, Richard Buist, Trevor J. Vincent, Jonathan D. Thiessen, Yanbo Zhang, Handi Zhang, Junhui Wang et al. "Comparison of manual and semi-automated segmentation methods to evaluate hippocampus volume in APP and PS1 transgenic mice obtained via in vivo magnetic resonance imaging." Journal of neuroscience methods 221 (2014): 103-111.

Thiessen, Jonathan D., Trevor J. Vincent, Sheryl L. Herrera, and Melanie Martin. "Diffusion Tensor Metric Measurements as a Function of Diffusion Time in the Rat central nervous system." Magnetic Resonance Insights 5 (2012): MRI-S10692. 5:3747.

Vincent, Trevor J., Jonathan D. Thiessen, Laryssa M. Kurjewicz, Shelley L. Germscheid, Allan J. Turner, Peter Zhilkin, Murray E. Alexander, and Melanie Martin. "Longitudinal brain size measurements in APP/PS1 transgenic mice." Magnetic Resonance Insights 4 (2010): MRI-S5885.

SELECTED AWARDS

NSERC CGSD Scholarship ($105000)	*2015*
NSERC CGSM Scholarship ($30000)	*2014*
Governor Generals Silver Medal	*2013*
CIHR Undergraduate Research Award ($5000)	*2013*
NSERC Undergraduate Research Award ($5000)	*2012*
NSERC Undergraduate Research Award ($5000)	*2011*
NSERC Undergraduate Research Award ($5000)	*2010*