TYLER W. HUGHES

Computational Physicist ⋄ 619 770 9446 ⋄ tylerwhughes91@gmail.com

ABOUT

I have a strong background in photoncs, machine learning, and software engineering. My main focuses are:

- Developing **simulation software** for computational electromagnetics, specifically combining numerical simulations with automatic differentiation for automated device design.
- Exploring novel approaches to **analog computing** in the optical domain for machine learning applications. Topics include optical backpropagation training, wave-based recurrent neural networks, among others.

EDUCATION

PhD, Applied Physics Sept 2014 - August 2019
Stanford University, Stanford, CA
PhD Thesis: *Adjoint-Based Optimization and Inverse Design of Photonic Devices*
Advisor: Prof. Shanhui Fan

Master of Science, Applied Physics Sept 2014 - June 2016
Stanford University, Stanford, CA

Bachelor of Science, Physics Sept 2009 - May 2013
University of Michigan, Ann Arbor, MI
With Distinction and Highest Honors —— GPA: 3.82/4.0

SELECTED WORK EXPERIENCE

Research Scientist Sept 2019 - present
Flexcompute *flexcompute.com*

· Leading development of the open source python frontend for the commercial simulation tool "Tidy3D".
· Main developer of the "adjoint" plugin for automatic differentiaion of Tidy3D simulations using JAX.
· Wrote an electromagnetic solver based on the boundary element method (BEM) for optical scattering.

Graduate Research Assistant Sept 2014 - Aug 2019
Stanford University, Shanhui Fan Group *https://web.stanford.edu/group/fan/*

· Invented novel approaches to analog machine learning in the optical domain. Work focused on optical backpropagation training, optical nonlinear activation functions, and analog RNNs, among other topics.
· Developed mathematical extensions to the "adjoint" method, used for gradient-based optimization of photonic devices. Wrote open source simulation packages showcasing these techniques with automatic differentiation.

Machine Learning Intern June 2018 - Sept 2018
Rasa Technologies *rasa.com*

· Researched strategies for extracting relevant information from text using named-entity recognition techniques.
· Contributed major feature to widely used open source software, enabling lookup table matching.

Junior Software Engineer Jan 2014 - Aug 2014
GudTech Inc. *gudtech.com*

· Performed full stack development of commercial software for inventory management applications.
· Designed a business intelligence tool based on multi-dimensional databases.

SELECTED PUBLICATIONS

Hughes, T. et al. *Training of photonic neural networks through in situ backpropagation.* Optica (2018).
Pai, S., Sun, Z., **Hughes, T.** et al. *Experimentally realized in situ backpropagation for deep learning in nanophotonic neural networks.* Science (2023).
Hughes, T. et al. *Wave Physics as a Recurrent Neural Network.* Science Advances (2019).
Hughes, T. et al. *Adjoint method and inverse design for nonlinear nanophotonic devices.* ACS Photonics (2018).
Hughes, T. et al. *Forward-mode differentiation of Maxwells equations.* ACS Photonics (2019).
Hughes, T. et al. *A perspective on the pathway toward full wave simulation of large area metalenses.* APL (2021).
Yamilov, A., Skipetrov, S.E., **Hughes, T.** et al. *Anderson localization of electromagnetic waves in three dimensions.* Nature Physics (2023).
Williamson, I. A. D., **Hughes, T.** et al. *Reprogrammable Electro-Optic Nonlinear Activation Functions for Optical Neural Networks.* IEEE JSTQE (2018).
Minkov, M. et al. *Inverse Design of Photonic Crystals through Automatic Differentiation.* ACS Photonics (2020).
Hughes, T. et al. *Reconfigurable Photonic Circuit for Controlled Power Delivery to Laser-Driven Accelerators on a Chip.* Physical Review Applied (2019).
Hughes, T. et al. *Method for Computationally Efficient Design of Dielectric Laser Accelerator Structures.* Optics Express (2017).
Hughes, T. et al. *On Chip laser power delivery system for dielectric laser accelerators.* Physical Review Applied (2018).
Hughes, T., Fan, S. *Plasmonic Circuit Theory for Multiresonant Light Funneling to a Single Spatial Hot Spot.* Nano Letters (2016).

PATENTS

- *Efficient Analog Backpropagation Training Architecture for Photonic Neural Networks* (2023).
- *Simultaneous measurements of gradients in optical networks* (2022).
- *Training Wave-Based Physical Systems as Recurrent Neural Networks* (2022).
- *Systems and Methods for Activation Functions for Photonic Neural Networks* (2022).
- *Training of Photonic Neural Networks Through in situ Backpropagation* (2021).

SKILLS

Programming	Python, C/C++, Julia (+ various others).
Technologies	Scientific python (numpy, scipy, xarray), jax, autograd, pytorch, Tensorflow.

OPEN SOURCE PROJECTS

Tidy3D	Hardware-accelerated FDTD Simulation Tool.	*link*
Ceviche	Electromagnetic FDFD Simulator with Automatic Differentiation.	*link*
Wavetorch	Pytorch-Based Wave Equation Solver and Analog RNN Design Tool.	*link*
Angler	Inverse Design Simulation Tool for Nonlinear Optics.	*link*
Symbolic Regression	Machine Learning Tool For Converting Raw Data into Equations.	*link*
Neuroptica	Optical Neural Network Systems Level Modeling and Simulation.	*link*
Rasa	Machine Learning Framework to Automate Text-Based Conversations	*link*

LINKS

Personal Website	twhughes.github.io
Google Scholar	scholar.google.com/citations?user=-AHhToYAAAAJ&hl=en
Github	github.com/twhughes
LinkedIn	linkedin.com/in/tylerwhughes