Blake Wilson

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Summary

I am a Ph.D. candidate with over eight years of experience in algorithm design and analysis and 12 years of experience in software engineering and leadership. I currently lead a team of 14 budding data scientists, engineers, and physicists, pioneering breakthroughs in statistical and geometric deep learning with applications in quantum algorithms, optics, renewable energy, quantum device engineering, semiconductor device authentication, risk-aware planning in autonomous package delivery, and open-source physics-inspired AI.

Skills

- Python | PyTorch | C/C++ | Julia | HTML | CSS | CUDA | HPC | Git | AWS | Linux | VLSI | CI/CD | Lambda | Neovim | Assembly
- Quantum | Deep Learning | Complexity | Numerical Methods | Computer Vision | Generative AI | Optimization | CEM | Optics
- Public Speaking | Grant Writing | Publishing | DEI | Conference Organizing | Open-Source | Research Leadership

Experience

Quantum Algorithms Researcher QuEra Computing *Cambridge, MA* **2022 – Present**

- Mobilized industry collaborations contributing to Series B funding by establishing quantum machine learning algorithms for renewable energy, chemical process efficiency, metalens design, neutral atom trapping, and Boltzmann latent diffusion models.
- Contributed to flagship, open-source scientific software for quantum simulations.
- Applied first-principles physics from non-Euclidean geometry and quantum information to develop and benchmark novel unsupervised deep learning architectures for neutral atom quantum computing and sampling. A very high-impact publication is being written with the goal of publishing in Nature.

Research Assistant Purdue University *West Lafayette, IN* **2016 – Present**

- Lead a research team resulting in 4 new foundational AI algorithms, 12 conference presentations, 4 project grants, 2 high-impact primary-author publications, 6 primary-author papers, 1 patent in progress, 30+ mentee research careers, 8 mentee research awards, 13 fireside chats, 3 career development workshops, 1 fully fabricated computer chip, and 4 poster sessions.

Resource Management

- Saved $40k in costs by programming machine learning servers for team experiments.
- Secured $10k across 4 project grants for quantum/cloud computing research.
- Increased machine learning job throughput by up to 300% by negotiating the purchase of five year contract for A100 GPU valued at $7k for computational electromagnetics and machine learning workloads.

Research Impact

- Engineered scientific software and deep learning algorithms for my group's productivity in experimental physics, leading to: a 55,000x speed-up in plasmonic measurements using attention networks, 12x speed-up and 50% accuracy improvement with transformer networks for applications in plasmonic material verification and semiconductor device security. These speed-ups are leading to a high-impact paper on detecting adversarial tampering and improved authentication in the semiconductor industry.
- Demonstrated a 162x speed-up using quantum machine learning optimization over state-of-the-art classical variational autoencoder optimization algorithms for optimizing nanophotonic device designs of diffractive meta-gratings and thermophotovoltaic cells.
- Demonstrated proof-of-concept for first demonstration of a quantum computer improving itself using a quantum optimization algorithm, i.e., quantum bootstrapping. Final data collection will be done in November 2023.

Leadership and Team Management

- Mentored undergraduate students into award-winning scientists and supporting them to earn internships at prestigious companies and research labs such as IBM Watson, Johns Hopkins, Cornell and several others.
- Currently, the team manages four research projects, with three proposals on the way, developing machine learning algorithms for measurement, fabrication, design, and optimization of nanophotonic and quantum devices, e.g., single-photon emitters in silicon nitride, thermophotovoltaic metasurfaces, metalenses for neutral atom trapping, and diffractive metagratings.

Software Engineer, Intern ARM *Austin, TX* **2019**

- Improved customer engineering workflow and test reproducability, immediately receiving positive feedback from customers, by rebuilding 2 ARMv8 intruction verification methods, and the random number generation system in ARM's verification suite, Raven, to reduce the complexity of debugging for customers.
- Simplified engineering testing and verification reproducability by improving the Chi-Square distribution of ARM's software verification suite random number generation from 0.2 to 0.5 by rebuilding the seed generation.
- Recovered a month's worth of lost code by navigating Git branches and server backups.
- Wrote statistical, scientific software in Python and C++ for ARMv8 instruction coverage verification under various random number generation schemes for verifying our statistical research.

Professional Activities

Advisor	Qiskit Fall Fest	2023 - Present
Committee Member	QSC Summer School	2022 - Present
First Time Researcher Fellowship Mentor	Purdue University	2022 - Present
SURF Graduate Mentor	Purdue University	2020 - 2023
Reviewer	Quantum	2022
Reviewer	Nature Communications	2022
Research Consultant	QuEra Computing	2022 - Present
Graduate Research Assistant	Purdue University	2019 - Present
Postdoctoral and Graduate Student Ass. Team Lead	Quantum Science Center	2021 - 2022
Poster Session Committee	Elmore Center	2022 - 2022
Graduate Teaching Assistant (Data Structures)	Purdue University	2021 - 2021
Graduate Research Assistant (Shreyas Sundaram)	Purdue University	2021 - 2021
Graduate Teaching Assistant (Advanced C)	Purdue University	2020 - 2020
ECE Shop Graduate Assistant	Purdue University	2019 - 2020
Verification Graduate Software Engineering Intern	ARM	2019 - 2019
Software Team Lead	SoCET Team, Purdue	2018 - 2019
SURF Fellow	Purdue University	2017 - 2017
Resident Assistant	Purdue University	2020 - 2021
Research Assistant	Purdue University	2016 - 2019

Education

Doctor of Philosophy Purdue University *West Lafayette, IN* **2019 – Present**

Electrical and Computer Engineering

Advisors: Alexandra Boltasseva, Sabre Kais, Vladimir Shalaev and Alexander Kildishev

Bachelor of Science Purdue University *West Lafayette, IN* **2015 – 2019**

Computer Engineering with a minor in Philosophy

Leadership Experience

Nanophotonics Machine Learning Team Lead Purdue Elmore Center **2021 – Present**

- Lead a team of undergraduate and graduate machine learning researchers for improving applications in nanophotonics, e.g., meta-optics design, fabrication, characterization and measurement.
- Since forming the team in 2021, we have given 9 conference presentations, published 1 preprint, earned 8 research awards, and are leading five research efforts in collaboration with Harvard, Microsoft and QuEra Computing.
- Our conference presentations and research awards have significantly elevated the profile of our lab, establishing it as a leading force in the integration of machine learning and nanophotonics.

Postdoctoral and Graduate Student Association Team Lead Quantum Science Center **2021 – 2022**

- Assisted in raising $100k+ through the Quantum Science Center and industry partners for the facilitation of the QSC Summer School. Played a pivotal role in coordinating poster sessions, leading panel discussions, promoting diversity, equity, and inclusion, organizing networking events, and inviting speakers at the 2022 and 2023 Quantum Science Center Quantum Summer Schools.
- The QSC Summer School at Purdue University is a highly-influential, 5 day quantum workshop bringing in over 120+ scientists from Fermilab, Oak Ridge National Lab, Los Alamos, Purdue, Harvard, and many other institutions from within the Quantum Science Center for promoting collaboration, graduate research engagement, and workforce development opportunities.
- Led a team of 10 researchers providing networking events to the QSC with leaders in industry (e.g., IBM Quantum, JPMorgan Chase, ColdQuanta, QuEra, Google), academia, (e.g., Harvard, MIT, Purdue, Technion) and national labs (e.g., Fermilab, Oak Ridge).

Graduate Assistant Purdue SURF **2020**

- Mentored a group of 20 undergraduate researchers in a cohort of 120+ to execute a research project from start to finish and guided their career development throughout the summer by leading career development seminars, workshops, and panel discussions.
- My committed mentorship led to my group clinching the highest number of awards at the SURF 2020 symposium and several students went on to become Ph.D. students at top universities like Cornell, Johns Hopkins, Purdue University, etc., and publish their work in top journals and conferences.
- Curated multidisciplinary research and assisted in preparing manuscripts of research in several disciplines, including biomedical imaging, computer science, chemical engineering, microelectronics and micromechanical systems, along with several others.

Fireside Chat Host Purdue ECE Stories of Success **2020 - 2021**

- Facilitated engaging monthly discussions with Purdue ECE alumni to give high school and undergraduate students opportunities to learn from successful alumni who've played key founding roles at Kickstarter, Tesla, and Facebook.
- Curated and hosted enlightening sessions with esteemed alumni, providing students unique insights and fostering valuable

connections to aid their career paths.

Software Engineer Team Lead Purdue System-on-Chip Team **2018 - 2019**

- Efficiently led the generation of essential RISC-V bootup code and a ROM module, overcoming multiple assembly programming challenges and ensuring the optimal functionality of a custom 90nm RISCV System-on-Chip at MIT Lincoln Labs, the AFTx04.
- Demonstrated proactive leadership by completing the boot-up code ahead of schedule, allowing extra time for in-depth debugging of the AFTx04 tapeout. Identified and rectified critical errors in the transistor netlist, paving the way for the SOC team's first successful tapeout. This pivotal success not only showcased the team's capabilities but also played a key role in securing future funding and projects focused on enhancing machine learning architectures on system-on-chip.
- The successful tapeout of the AFTx04, achieved under my leadership, solidified the reputation of the SOC team and propelled further research and funding in machine learning architectures on system-on-chip, underlining the long-term impact and significance of the project's success

Leadership Positions

NanoMeta Machine Learning Team Lead	NanoML Team	2021 - Present
Quantum Science Center Summer School Committee	Quantum Science Center	2021 - Present
Quantum Science Center PGA Team Lead	Quantum Science Center	2021 - 2022
SURF Graduate Mentor	Purdue SURF	2022 - Present
Elmore Center Poster Session Committee	Elmore Center	2022
Graduate Teaching Assistant	Purdue ECE	2020 - 2021
SURF Graduate Assistant	Purdue SURF	2020
SURF Symposium Planning Committee	Purdue SURF	2020
Stories of Success: Fireside Chat Host	Purdue ECE	2019 - 2020
ECE Shop Graduate Assistant	Purdue ECE	2019 - 2020
Software Team Lead	SoCET Team, Purdue	2018 - 2019
Resident Assistant	Purdue University	2020 - 2021
Volunteer Robotics Teacher	Muslim Learning Society	2014
First Robotics Software Team Lead	Plainfield Earthquakers	2013 - 2015
Video Game Lead Developer	Wired Vision Games	2012 - 2015

Current Projects

1. Wilson, B., Wurtz, J. Mkhitaryan, V., Wang, S., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Quantum Bootstrapping by Quantum-Enhanced Latent Boltzmann Sampling of Neutral Atom Metalens Traps**. [Status: Final dataset collection and manuscript prep]
2. Wilson, B., Chen, Y., Singh, D.K., Ojha, R., Pottle, J., Bezick, M., Boltasseva, A., Shalaev, V., Kildishev, A. **Machine Learning Realization of Random Plasmonic Physical Unclonable Functions**. [Status: Manuscript prep]
3. Wilson, B., Triplett, B., Singh, D.K., Chen, Y., Cantu, S., Kais, S., Shalaev, V., Kildishev, A., Boltasseva, A. **Metalens Design for Optimal Trapping of Rydberg Atoms**. [Status: Simulation Data Collection]
4. Wilson, B., Dongeun, L., Bezick, M., Malavathu, R., Lackey, B., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Beyond Classical Ising Models: Quantum Inspired Latent Diffusion Models**. [Status: Data Collection]

All Publications and Preprints

1. Wilson, B., Dickey, E., Iyer, V., & Kais, S. **A Relative Church-Turing-Deutsch Thesis from Special Relativity and Undecidability**. [Status: In Peer-Review, Preprint: arXiv:2206.06419]
2. Wilson, B., Hudack, J., & Sundaram, S. (2022). **Planning for Package Deliveries in Risky Environments Over Multiple Epochs**. American Controls Conference 2022. [Preprint: arXiv:2110.09917]
3. Wilson, B., Kudyshev, Z., Kildishev, A., Shalaev, V., Kais, S., & Boltasseva, A. (2021). **Machine Learning Framework for Quantum Sampling of Highly-Constrained, Continuous Optimization Problems**. Applied Physics Reviews, 8, 041418. [Impact Factor: 19.16] [Preprint: arXiv:2105.02396]
4. Wilson, B., Kudyshev, Z., Kildishev, A., Shalaev, V., Kais, S., & Boltasseva, A. (2021). **Metasurface Design Optimization via D-Wave based Sampling**. CLEO 2021.
5. Wilson, B. **Bounds on Sweep-Covers by Raney Numbers**. [Status: Preprint, arXiv:2009.08549]
6. Wilson, B., Prasad, A., & Sundaram, S. **Multiple Pursuers Under Partial Information from Sensors**. [Status: Preprint, www.blakewilson.org/publications]

All Conference Presentations

1. Singh, D.K., Ojha, R., Chen, Y., Wilson, B., Bezick, M., Boltasseva, A., Shalaev, V., Kildishev, A. **Machine Learning Realization of PUFS with Random Plasmonic Systems**. CI + AI Cyberinfrastructure Symposium (2023)
2. Bezick, M., Wilson, B., Boltasseva, A. **Latent Diffusion for Material Topology Sampling**. CI + AI Cyberinfrastructure Symposium (2023)
3. Wilson, B., Iyer, V., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Learning Van der Waals Potentials in Surrogate Rydberg Hamiltonians**. 3rd Annual Quantum Summer School (2023)
4. Bezick, M., Wilson, B., Boltasseva, A. **Denoising Diffusion for Material Topology Sampling**. Spring Undergraduate Research

Conference (2023)

5. Singh, D.K., Chen, Y., Wilson, B., Boltasseva, A., Shalaev, V., Kildishev, A. **Plasmonic nanoparticle densities for physical verification of unclonable spectral tags in microelectronics packaging**. Spring Undergraduate Research Conference (2023)
6. Wilson, B., Chen, Y., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Empowering Quantum 2.0 Devices and Approaches with Machine Learning (QTu2A.13)**. Quantum 2.0 (2022)
7. Wilson, B., Iyer, V., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Metasurface Compression Analysis via bVAE Reconstruction Loss**. ECE Elmore Emerging Frontiers Center Poster Session (2022)
8. Wilson, B., Mkhitaryan, V., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Source Shaping for Electromagnetic Optimization via Higher-Order Variational Quantum Algorithms**. 2nd Annual Quantum Summer School (2022)
9. Wilson, B., Chen, Y., Shalaev, V., Kildishev, A., Kais, S., Boltasseva, A. **Machine Learning for Nanophotonic Design and Quantum Measurements**, Purdue Elmore Center (2021)

Expertise

- **Foundational Physics:** Quantum Information, General Relativity, Riemannian Geometry, Boltzmann sampling
- **Machine Learning for Experimental Physics:** semantic segmentation of plasmonic systems, siamese networks, generative modeling for fabrication, attention architectures for material design, computer vision for measurement speed-up, stable diffusion for material design sampling, quantum-enhanced Boltzmann sampling for quantum bootstrapping and Bayesian learning
- **Scientific Software Engineering:** Git, Python, CUDA, C/C++, Julia, Neovim, Linux, Markdown, Github Organizations, Github Actions, continuous integration, AWS Braket, D-Wave Cloud, CSS, HTML
- **CS Theory:** quantum Turing machines, complexity theory, asymptotic analysis, algorithm design and analysis, Bayesian inference, statistical analysis, convex optimization, information theory, data structures
- **Computational Electromagnetics:** Finite element methods, Green's function, device simulation, numerical methods, Lumerical
- **Professional Skills:** Public speaking, science communication, workforce development, diversity equity and inclusion

Software Engineering Projects

NanoMetaML Elmore Frontiers Center 2022-2023

- Developing software for machine learning assisted optimization of meta-optics designs, generative models, sampling algorithms, and CUDA accelerated Markov Chain Monte Carlo.
- Github actions for automated web testing and integration of student code.
- Built NanoMetaML using HUGO and custom CSS/HTML.

Lumenodes Purdue ECE Senior Design *West Lafayette, IN* **2018-2019**

- Led the firmware development of the PWM controller firmware for controlling a set of synchronized RGB uniform marching band lights for the Purdue All-American Marching Band.
- Developed firmware for controlling pulse-width modulation control of LED's, Bluetooth low-energy API, and
- Project Link: https://www.blakewilson.org/lumenodes

AFTx04 Tapeout Purdue System-on-Chip Team *West Lafayette, IN* 2018-2019

- Developed a Python tool to compile C code into RISCV machine code and onboard the machine code into a Verilog ROM module compatible with the SOC protocols.
- After finishing the ROM module early, I fixed critical bugs in the system-on-chip from source code to netlist level. This work directly led to the team's first completely functional SOC and led to future research projects, including integrated machine learning projects, and more funding for the next version of the chip.
- Developed test vectors for verifying the SOC with NSWC Crane and MIT-Lincoln Lab engineers.

Extended Software Project Experience

Web Development	NanoML Team	2023 - Present
Custom Arch Linux Setup	Linux	2022 - Present
Neovim Personal Configuration	Linux	2022 - Present
ClearML Server Management	Linux	2022 - Present
Bloqade Rydberg Atom Simulations	QuEra Computing	2022 - Present
NanoML Experiment Manager	Python	2023
OpenAI Automatic Documentation Builder	OpenAI	2023
OpenAI + Alexa API Integration	OpenAI	2022
CEM Codes (Diffraction, Capacitor)	Purdue ECE	2021
ECE Shop Sign (RGB LED + Web Server)	Purdue ECE	2019
Bluetooth Controlled Powerstrip	Purdue ECE Embedded Sys.	2018
32-bit MIPS Processor from scratch	Purdue ECE 437	2018
VLSI Clock-Tree Synthesis Project	Purdue ECE 595	2018
Ethernet Packet Sniffer	Purdue ECE 337	2018
Multiple Pursuers and Sweep-Covers Enumeration	Purdue ECE Research	2017
8-bit Breadboard PC - Synchronized Clock	Personal Hobby	2017

Tanvas Image Processing and Material Analysis	Northwestern Hackathon	2016
Zombie Video Game	Wired Vision Games	2014
Falling Balls Android Game	Personal Hobby	2013

Awards

Fellowships

Summer Undergraduate Research Fellowship	Purdue University	2017

Grants

AWS Braket Research Grant	Amazon	2023 - 2024
ACC 2022 Student Travel Grant	ACC 2022	2022
Universities Space Research Association Quantum (Cycle 4)	NASA Ames Center	2020 – 2021
Leadership Computing Facility D-Wave	Oak Ridge	2020

Competitions

2nd Place National Rube Goldberg Competition	Purdue University	2016
2nd Place Purdue First Robotics Regionals	Purdue University	2014
3rd Place IUPUI Mathematics Competition	IUPUI	2014

Funding

Quantum Science Center	Oak Ridge	2021 - Present
Purdue Elmore Emerging Frontiers Center	Elmore Family	2022 - Present
Quera Computing	Harvard/MIT	2022
Air Force Research Lab	AFRL	2021

Mentee Awards*

Qiskit Fall Fest Lead	Vaishnavi Iyer	2023
Best Poster Presentation	Daksh Kumar Singh	SURF 2023
Summer Undergraduate Research Fellowship	Daksh Kumar Singh	SURF 2023
First Time Researcher Fellowship	Daksh Kumar Singh	EURO 2023
First Time Researcher Fellowship	Michael Bezick	EURO 2023
IBM Watson Quantum Summer Internship	Vaishnavi Iyer	2023
Summer Undergraduate Research Fellowship	Vaishnavi Iyer	2022
Best First Time Researcher Award	David Czerwonki	SURF 2020
Best First Time Researcher Award	Rachel Zhang	SURF 2020

*These awards were given to my mentees for their incredible work. I place them on my C.V. because I'm heavily invested in their success and directly guided the work that contributed to their awards through editing, ideating, and spending hours of personal time mentoring their final submissions.

Personal Accomplishments

Built Zombie Video Game	Wired Vision Games	2014
Published Android App on Google Play Store	Personal Hobby	2013

Mentees

Trang Do	Elmore Center	2023 - Present
Geetika Chitturi	Elmore Center	2023 - Present
Lee Dongeun	Elmore Center	2023 - Present
Rohan Malavathu	Elmore Center	2023 - Present
Rohan Ojha	Elmore Center	2023 - Present
Jaxon Pottle	Elmore Center	2023 - Present
Daksh Kumar Singh	Elmore Center	2022 - Present
Michael Bezick	Elmore Center	2022 - Present
Vaishnavi Iyer	Elmore Center	2021 - Present
Seoyoung Cho	Elmore Center	2023
Daria Shkel (Cornell)	Purdue SURF	2020
Rachel Zhang (University of Michigan)	Purdue SURF	2020
David Czerwonky (Purdue University)	Purdue SURF	2020
Emi Mondragon (Johns Hopkins)	Purdue SURF	2020

Affiliations

QuEra Computing	Harvard/MIT	2022 - Present
Quantum Science Center	Oak Ridge National Lab	2020 - Present
Elmore Emerging Frontiers Center	Purdue University	2020 - Present
Purdue Quantum Science and Engineering Institute	Purdue University	2019 - Present
Optica	Optica	2021 - Present

IEEE Computer Society	IEEE	2020 - 2021
Purdue Society of Professional Engineers	Purdue University	2015 – 2016
Wired Vision Games	Game Development Group	2011 – 2015
First Robotics	NASA	2013 – 2015
Freedom Chairs (Charity Wheelchair Repair)	Indiana Non-Profit	2013 – 2015
Project Lead the Way	Indiana Non-Profit	2011 – 2013

References

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