

# Nolan Black, Ph.D. | Simulation Engineer

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## Education

### Ph.D., Mechanical Engineering / Computer Science

Drexel University, Philadelphia, PA

September 2020 – December 2024

Thesis: Multiscale Structural Optimization through Second-order Homogenization and Machine Learning

### B.S./M.S., Mechanical Engineering

Drexel University, Philadelphia, PA

September 2016 – June 2020

## Areas of Interest

### Computational Mechanics

- Multiscale solid mechanics
- Topology optimization

### Machine Learning

- Physics-informed machine learning
- Multi-fidelity data analysis

## Research Experience

### Pasteur Labs | Scientific ML Startup

Denver, CO

#### Simulation R&D Engineer

January 2025 – Present

- Automated data generation workflows for CFD, computational mechanics, and multiphysics data generation that accelerated the training of ML surrogate models
- Designed a data generation API that connects existing CAE modeling frameworks, enabling surrogate modeling training on data from Ansys, Siemens, and open-source software
- Designed and programmed differentiable interfaces to perform structural optimization of pre-trained ML surrogates in aerospace applications (Python/PyTorch)

### Drexel University | GAANN Fellowship

Philadelphia, PA

#### Graduate Research Assistant

September 2020 – January 2025

- Developed high-performance finite-element models for multiscale design optimization (C++/PETSc)
- Investigated novel methods of Machine Learning (ML) for physics-informed simulation (C++/Python/PyTorch)
- Integrated ML techniques to design nature-inspired metamaterials with tailorable physical properties

### Lawrence-Livermore Nat. Lab. | Center for Design Optimization

Livermore, CA

#### NSF PhD INTERN

January 2024 – May 2024

- Implemented parallel solvers for mixed finite element methods in a high-performance computing environment (C++)
- Developed nonlinear finite element programs for hyperelastic, hierarchical materials for applications in structural optimization

## Select Publications

**Black, Nolan and Najafi, Ahmad R.** (2024), *Stress-constrained optimization of multiscale structures with parameterized microarchitectures using machine learning*. Struct. Multidiscip. Optim., 10.1007/s00158-024-03821-y.

**Black, Nolan and Najafi, Ahmad R.** (2023), *Deep neural networks for parameterized homogenization in concurrent multiscale structural optimization*. Struct. Multidiscip. Optim., 10.1007/s00158-022-03471-y.

**Black, Nolan and Najafi, Ahmad R.** (2022), *Learning finite element convergence with the Multi-fidelity Graph Neural Network*. Comput. Methods Appl. Mech. Eng., 10.1016/j.cma.2022.115120.

**Black, Nolan and Najafi, Ahmad R.**, *Second-order homogenization in multiscale structural optimization*. Manuscript under peer review.

**Black, Nolan and Najafi, Ahmad R.**, *Neural networks for nonlinear homogenization in multiscale structural optimization*. Manuscript under peer review.

## Select Conference Presentations

**Black, Nolan and Najafi, Ahmad R.**, "Multiscale structural optimization with strain gradient effects using second order homogenization". World Congress on Computational Mechanics (WCCM2024), Vancouver, BC, July 21-26, 2024.

**Black, Nolan and Najafi, Ahmad R.**, "Second-order Homogenization for Structural Optimization Applications". Engineering Mechanics Institute Conference 2024 (EMI2024), Chicago, IL, May 28-31, 2024.

**Black, Nolan and Najafi, Ahmad R.**, "Multiscale Design Optimization with Local Failure Criteria through Machine Learning". 17<sup>th</sup> U.S. National Congress on Computational Mechanics (USNCCM17), Albuquerque, NM, July 23-27, 2023.

**Black, Nolan and Najafi, Ahmad R.**, "Neural Network Surrogates for Multiscale Structural Optimization". 2022 International Mechanical Engineering Congress and Exposition (IMECE 2022), Columbus, OH, Oct. 30 – Nov. 02, 2022.

**Black, Nolan and Najafi, Ahmad R.**, "Multi-Fidelity Graph Neural Networks as Surrogate Models for Finite Element Analysis". 19<sup>th</sup> U.S. National Congress on Theoretical and Applied Mechanics (USNCTAM19), Austin, TX, June 19-24, 2022.

**Black, Nolan and Najafi, Ahmad R.**, "Deep Learning in Concurrent Multiscale Structural Optimization". 19<sup>th</sup> U.S. National Congress on Theoretical and Applied Mechanics (USNCTAM19), Austin, TX, June 19-24, 2022.

**Black, Nolan and Najafi, Ahmad R.**, "Incorporating Architected Materials in Multiscale Structural Optimization with Deep Learning". Engineering Mechanics Institute Conference 2022 (EMI2022), Baltimore, MD, May 31-June 3, 2022.

## Scholarships, Fellowships, and Honors

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- NSF Non-academic Research Internship (INTERN) Award (2024)
- Koerner Family Foundation Fellowship (2022)
- Harry L. Brown, Jr. Memorial Fellowship (2021)
- Fellow, U.S. E.D. Graduate Assistance in Areas of National Need (2020-Present)
- A.J. Drexel Scholarship, Drexel University (2016–2020)

## Professional Affiliations and Service

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- Student Representative, Graduate Studies Committee, Drexel University (2022–2023)
- Entrepreneurial Lead, NSF I-Corp (2022–2023)
- Member, The American Society of Mechanical Engineers (2016–Present)

## Teaching and Mentorship

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### **MEM592**

*Applied Engineering Analytical & Numerical Methods II, Drexel University*

Co-teacher and Teaching Assistant

### **Graduate Research Mentor**

*Drexel University*

Served as primary mentor for one M.S. thesis.

### **Undergraduate Research Mentor**

*Drexel University*

Served as primary mentor for three undergraduate researchers.

## Professional Experience

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**Zimmer Biomet** | Zimmer Knee Creations R&D

Exton, PA

*Development Engineering Coop*

April 2019 – April 2020

- Developed functional medical devices using rapid prototyping to perform orthopedic procedures on the hand and wrist
- Established design criteria to meet surgeon input and verified design features in cadaveric lab testing
- Adapted, tested, and re-validated existing products to meet new standards of quality based on risk management
- Prepared and executed test protocols to analyze new product aging, transit, and functional capabilities

**NAVSEA** | Department of the Navy

Philadelphia, PA

*Entry-level Engineer*

April 2017 – September 2018

- Drafted procedures and diagrams for US Navy shipboard engineering systems
- Coordinated small-team projects to overhaul procedures and diagrams, thereby increasing operating efficiency
- Communicated objectives with ship's force onboard Nimitz-class carriers, LCU, and Arleigh Burke destroyers