Siavash Monfared

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google scholar page

Qualifications Summary

Computational physicist with deep expertise in statistical modeling, data-driven inference, and scalable scientific computing. Proven ability to build end-to-end pipelines; from complex Bayesian models and LLM agent workflows to GPU-accelerated simulations; for extracting insight from large-scale, noisy datasets. Skilled in hypothesis-driven research, uncertainty quantification, and deploying reproducible, high-performance analytics. U.S. Citizen.

Education

Ph.D., Massachusetts Institute of Technology (MIT) — Cambridge, MA
Department of Civil & Environmental Engineering; Computational physics — 2015 - 2019

S.M., Massachusetts Institute of Technology (MIT) — Cambridge, MA
Department of Civil & Environmental Engineering; Engineering mechanics — 2012 - 2015

B.S., University of Oklahoma — Norman, OK
College of Earth & Energy; Geomechanics; minor in Mathematics — 2008 - 2012

Skills

Programming Languages:	Python, C++, Julia, MATLAB, Mathematica
Libraries & Frameworks:	scikit-learn, PyTorch, Keras, XGBoost, PyMC, LangChain, LangGraph, FAISS, Pandas, NumPy, SciPy
Modeling & AI Expertise:	Hierarchical Bayesian methods, Regression, Classification, Time-series forecasting, Transformer architectures, Multi-agent systems, High performance computing, Parallel programming
Tools & Infrastructure:	Git, AWS, Linux, Unix, CUDA programming, MPI, OpenMP

Experience

Flagship Pioneering — Cambridge, MA
Associate, Science and AI Venture Origination — 10/2025 -

- ◇ Evaluate emerging AI technologies and scientific methodologies to identify high-impact venture opportunities in computational life and social sciences.
- ◇ 2025 AIML Summer Fellow.

Niels Bohr Institute (Department of Physics), University of Copenhagen — Copenhagen, Denmark
Postdoctoral scholar, visiting Department of Physics, Harvard University — 9/2022 - 8/2025

- ◇ Discovered fundamental physics based mechanisms that influence biological processes using data-driven approaches.
- ◇ Developed and implemented a multiphase-fields model as a high performance computational tool to study the nonequilibrium statistical physics of proliferating active agents in three-dimensions.
- ◇ Engineered automated pipelines to process large data sets, computing spatial and temporal correlations, analyzing dynamic and static structural properties, extracting topological features, and performing advanced statistical analyses to identify patterns and insights in large-scale datasets.

Division of Engineering & Applied Science, California Institute of Technology — Pasadena, CA
Postdoctoral scholar — 4/2019 - 8/2022

- ◇ Supervised development of deep generative models to classify particle morphology for topological optimization of granular structures, leveraging large-scale simulations and advanced data processing.
- ◇ Coordinated multi-institutional data science projects, supervised data analysis and model development with over 20 scientists and engineers in a project sponsored by the U.S. Army and academic research institutions to advance understanding of wet granular materials.
- ◇ Advised 10 undergraduate research projects, one featured in Caltech Undergraduate Research Journal.

Department of Civil & Environmental Engineering, MIT — Cambridge, MA
Graduate research assistant — 9/2012 - 3/2019

- ◇ Developed a computational framework to model highly heterogeneous solids resulting from random field interactions, optimizing stochastic interaction parameters using nonlinear techniques to fit the full data distribution.
- ◇ Discovered novel fundamental mechanism responsible for fluid confinement by developing a computational framework, based on lattice-gas density functional theory and using advanced statistical models applied to large data-sets.

Cabot Undergraduate House, Harvard University — Cambridge, MA
Resident science tutor — 1/2017 - 3/2019

- ◇ Lived among over 400 undergraduate students and directly advised over 20 students of diverse backgrounds.
- ◇ Tutored students on physical sciences, engineering, and math on weekly basis.
- ◇ Advised students on graduate school applications, research fellowships, and non-academic career paths.

Selected Awards & Grants

- *'Les Grandes Avancées en Biologie' award winner*, The French Académie des Sciences, Paris, France, 2025.
- *The Leon Rosenfeld Foundation Fellowship*, The Niels Bohr Institute, University of Copenhagen, Denmark, 2022.
- Research grant: Emergent mechanical behavior of disordered granular structures, Army Research Office, URAP ARO-W911NF-17-S-0002-05, 2020.

Software

- **Cells As Liquid Droplets 3D (Celadro-3D):** Developed the theoretical formulation, designed the software architecture and implemented a 3D multi-phase fields model leveraging finite-difference methods and GPU acceleration (CUDA). This software package was developed to efficiently simulate the collective dynamics biological cells and non-equilibrium statistical physics of active matter, utilizing high-performance computing for scalable and computationally intensive simulations.
- **Coarse-Grained Density Functional Theory (CG-DFT):** Developed the theoretical formulation, designed the software architecture and implemented a 3D coarse-grained lattice-gas density functional model using finite-difference techniques. Implemented Message Passing Interface for full domain decomposition, allowing for distributed computing across multiple CPUs. This software framework was applied to explore the thermodynamics and statistical mechanics of confined fluids, providing scalable solutions for large-scale simulations.
- **Lattice Element Method (LEM):** Developed, designed and implemented a 3D discrete computational solid mechanics framework using finite-difference methods and Message Passing Interface for full domain decomposition across multiple CPUs. This software was specifically designed to simulate the mechanics of highly heterogeneous solids by incorporating multiple interacting random fields.

Selected Publications

- Schoenit*, A., **Monfared*, S.**, Anger*, L., Rosse, C., Venkatesh, V., Balasubramaniam, L., Marangoni, E., Chavrier, P., Mège, R.-M., Doostmohammadi, A., Ladoux, B. (2025). Force transmission is a master regulator of mechanical cell competition. *Nature Materials* (*first co-authorship).
- Balasubramaniam*, L., **Monfared*, S.**, Ardaševa, A., Rosse, C., Schoenit, A., Dang, T., Maric, C., Kocgozlu, L., Dubey, S., Marangoni, E., Doss, B.L., Chavrier, P., Mège, R.-M., Doostmohammadi, A., Ladoux, B. (2025). Dynamic forces shape the survival fate of eliminated cells. *Nature Physics* (*first co-authorship). Press coverage: Phys.org.
- **Monfared, S.**, Ardaševa, A., Doostmohammadi, A. (2025). Multi-phase-field Models of Biological Tissues. Invited article for *Annual Review of Condensed Matter Physics*.
- **Monfared, S.**, Ravichandran, G., Andrade, J.E., Doostmohammadi, A. (2024). Short-range correlation of stress chains near solid-to-liquid transition in active monolayers.. *The Journal of Royal Society Interface 21: 20240022*.
- **Monfared, S.**, Ravichandran, G., Andrade, J.E., Doostmohammadi, A. (2023). Mechanical basis and topological routes to cell extrusion. *eLife*, 12:e82435. Press coverage: Caltech press, Phys.org.
- Buarque de Macedo, R., **Monfared, S.**, Karapiperis, K., Andrade, J.E. (2023). What is shape? characterizing particle morphology with genetic algorithms and deep generative models. *Granular Matter*, 25(2).
- Karapiperis, K., **Monfared, S.**, de Macedo, R.A., Richardson, S. and Andrade, J.E. (2022). Stress transmission in entangled granular structures. *Granular Matter*, 24(91), 1369-1394. Press coverage: APS News.
- **Monfared, S.**, Zhou, T., Andrade, J.E., Ioannidou, K., Radjai, F., Ulm, F.-J., Pellenq, R.J.-M. (2020). The effect of confinement on capillary phase transition in granular aggregates. *Physical Review Letters*, 125, 255501.
- **Monfared, S.**, Laubie, H., Radjai, F., Hubler, M., Pellenq, R.J.-M., and Ulm, F.-J. (2018). A methodology to calibrate and to validate effective solid potentials of heterogeneous porous media from computed tomography scans and lab measured nanoindentation data. *Acta Geotechnica*, 13(6), 1369-1394.
- **Monfared, S.**, Laubie, H., Radjai, F., Pellenq, R.J.-M., and Ulm, F.-J. (2017). Mesoscale poroelasticity of heterogeneous media. *Journal of Nanomechanics and Micromechanics*, 7(4).

Selected Invited Talks

- **Transmission of mechanical information in living cells**, *Physics of Living Systems Short Talk, Department of Physics, MIT, Cambridge, MA, October 2023.*
- **Collective cell communication via intercellular force transmission**, Conference on *Crossing the Disciplinary Boundaries of Physics - Bohr 100 Centennial Celebration, Copenhagen, Denmark, August 2023.*
- **What is shape? Characterizing particle morphology with genetic algorithms and deep generative models**, conference on *Getting into Shape – Pushing for Exotic Particulate Media Mechanics. Lorentz Center, Universiteit Leiden, Leiden, Netherlands, June 2023.*
- **Force transmission informs the collective behavior of active cell layers**, *Center Of Mathematical Sciences And Applications Active Matter Seminar Series, Harvard University, Cambridge, USA, November 2022.*
- **Mechanical routes to cell extrusion in 3D cellular monolayers.** *Active & Intelligent Living Matter Conference, Erice, Italy, July 2022.*
- **Mechanics & Physics of Discrete, Disordered Systems**, *Department of Mechanical Engineering, University of Michigan, Ann-Arbor, MI, USA, April 2022.*
- **Complex Poromechanics**, *Mechanical & Civil Engineering Department, California Institute of Technology, Pasadena, CA, USA, May 2020.*