

Habib Latifzadeh, Ph.D.

 Google Scholar |  LinkedIn |  HL537@duke.edu

Education, Training & Appointments

- Visiting Scholar & Project Co-Investigator** · Massachusetts Institute of Technology 2026 – 2027
 - Postdoctoral Associate** · Duke University — Department of Biostatistics & Bioinformatics 2024 – 2026
 - NSF Advanced Certificate (BridgesDH NRT)** · National Science Foundation 2026
 - NSF NRT Fellow — AI & Machine Learning for Digital Health** · WVU Cancer Institute 2023–2024
 - Ph.D., Applied Mathematics** · West Virginia University, WV 2017 – 2024
Dissertation: Developing a Data-Driven Method for Inferring Heterocellular Networks in Cancer.
 - B.Sc. and M.Sc. (Graduated with honors), Applied Mathematics** · Iran 2007, 2010
- Credentialed Training:** Human-Subjects Research Ethics, Good Clinical Practice (GCP), and HIPAA Clinical Data Privacy — CITI Program, Duke Health, 2026.

Research Interests

Trustworthy Clinical AI, Multimodal Health Data, Causal Inference, Single-Cell & Immune Multiomics & Uncertainty Quantification

Professional Experience

- Visiting Scholar & Project Co-Investigator** · Massachusetts Institute of Technology 2026 – 2027
Laboratory for Computational Physiology, MIT Critical Data
- **Reliability and harm evaluation of multimodal clinical AI.** Evaluating ensembles of deep-learning diagnostic imaging models (20 architectures: CNNs, vision transformers, hybrids) for multi-task diagnostic classification; quantifying *image-level error accumulation* via a consensus-based “harm” score that flags the examinations and patients most vulnerable to AI error.
- **Cross-modal AI vulnerability & ICU care phenotyping.** Linking imaging-model harm scores to ICU *care phenotypes* from linked tabular EHR and chest-radiograph data (MIMIC-IV, MIMIC-CXR; PhysioNet-credentialed; encounter-level linkage, temporal alignment). Building end-to-end ML pipelines; training, calibration, uncertainty quantification, threshold/severity-sensitivity analysis, and subgroup/fairness auditing; with causal framing to test whether AI-vulnerable patients share latent clinical or care-delivery signals.
- Postdoctoral Associate** · Duke University 2024 – 2026
Department of Biostatistics & Bioinformatics — Joint NIH-funded Duke–Weill Cornell Medicine project with the congenital CMV (cytomegalovirus) team; research spanning multi-scale modeling, cross-species cellular alignment, and clinical ML.
- **ML-integrated multiscale modeling for biomedical systems.** Designing reproducible frameworks coupling mechanistic simulators (agent-based models, ODEs) with classical ML, large language model (LLM) workflows, and deep neural architectures for biomedical dynamics; employed gradient-boosted trees with Bayesian hyperparameter optimization, Gaussian-process surrogates for uncertainty-aware emulation, and *physics-informed neural networks* to embed domain constraints.
- **Cross-dataset harmonization for cytometric / omics measurements.** Built end-to-end pipelines with quality assurance, batch correction, and feature engineering; aligned distributions via *optimal transport with relaxed marginals* on Gaussian-mixture embeddings (Python, scikit-learn); integrated graph clustering (Leiden / igraph) with Wasserstein-grounded distances; containerized workflows with Docker and scaled analyses on SLURM/HPC.
- NSF NRT Research Fellow in AI and Machine Learning** · National Science Foundation 2023–2024

Two-year, stipend-bearing graduate research traineeship; Digital Health track (Award #2125872).

- **Scalable platform for causal network inference from high-dimensional biomedical signals.** Designed a platform integrating probabilistic graphical models with constraint and score-based structure learning; implemented conditional-independence testing with multiple-hypothesis correction and bootstrapping for stability assessment; improved computational efficiency for targeted high-dimensional causal-discovery workloads relevant to biomolecular and clinical-relation inference.
- **Causal modeling of cellular drivers of disease progression and drug response.** Developed a data-driven framework to identify and quantify the causal effects of cellular components on disease progression and treatment response, revealing communication patterns between tumors and the host immune system relevant to immuno-oncology.
- **Deep learning for multi-source biological signal decomposition.** Trained CNN architectures to separate aggregated molecular and tissue-scale signals into interpretable components, including computational deconvolution methods estimating cell-type abundance and cellular phenotypes from RNA and tissue gene-expression profiles (applicable in computational pathology, molecular profiling, and clinically informed signal decomposition). Employed transfer learning, augmentation, and regularization with disciplined optimization (early stopping, learning-rate schedules, multi-objective losses).

■ **Machine Learning Researcher** · West Virginia University — WVU Cancer Institute 2020 – 2023
Machine Learning in Systems Biology Lab

- **Generative modeling for high-dimensional biomedical sequence data.** Developed *VAEs* and *Wasserstein GANs with gradient penalty* for synthesis and representation learning; applied latent regularization, disentanglement, and class-conditional generation; leveraged synthetic samples for domain adaptation in biomedical prediction tasks.
- **Ensemble Bayesian network modeling for causal machine learning in biological systems.** Developed ensemble Bayesian structure learning with MCMC posterior exploration over graph spaces for robust causal discovery and parameter estimation; deployed across multi-source datasets with explicit uncertainty quantification for downstream reasoning.
- **Cancer systems & network immunology analytics.** Characterized how Cell Communication Network 4 (CCN4/WISP1) reorganizes local regulatory context linked to anti-tumor immunity in breast cancer and melanoma; established graphical-modeling workflows for gene-regulatory analysis and deconvolution methods.

■ **Computational Modeling & ML Ph.D. Researcher** · West Virginia University 2020 – 2023
School of Mathematical & Data Sciences

- Stability analysis of biochemical reaction networks using dynamical-systems and bifurcation theory for disease-dynamics and intervention modeling. Implemented Runge–Kutta integration, automatic-differentiation sensitivity analysis, and maximum-likelihood inference; applied stochastic differential equations and Monte Carlo simulation for uncertainty propagation in dynamical biomedical models.

■ **Research Scholar & Project Lead** · Shiraz University of Technology 2010 – 2017
Computational Applied Mathematics Lab

- Designed and developed high-performance algorithms for nonlinear dynamical systems using spectral methods and finite-element analysis; improved computational speed through algorithmic optimization and vectorization, enabling responsive simulation and sensitivity analysis in high-dimensional parameter regimes that arise in modern data-science workflows.
- Conducted interdisciplinary mathematical-modeling research in collaboration with researchers across multiple international institutions; published 10 peer-reviewed articles in computational and applied-mathematics journals; served as a peer reviewer; mentored three M.Sc. students through thesis research.
- Excellence in Graduate Research and Exceptional Talented awards (2010).

■ Selected Publications

Manuscripts in Preparation

- [Mi] Transferable Cross-Species Cell-Type Mapping via Relaxed-Marginal Probabilistic Optimal Transport Learning and Out-of-Sample Inference in Flow Cytometry. **Lead Author**; joint Duke–Weill Cornell Medicine collaboration (Congenital CMV Research Team), 2026. ♦ *Methods manuscript on reproducible cross-species alignment of flow-cytometry measurements via probabilistic optimal transport; supports standardized biological-data integration and transferable inference, with potential future relevance to multi-site clinical-data harmonization.*
- [Mii] A Multi-Scale Scientific Machine Learning Framework for In Silico Modeling of Maternal Immunity and Vaccine Efficacy in Congenital CMV Transmission. **Lead Author**; joint Duke–Weill Cornell Medicine collaboration (Congenital CMV Research Team), 2026. ♦ *Translational modeling manuscript integrating mechanistic simulation with scientific machine learning to study maternal immunity, vaccine efficacy, and congenital CMV transmission; supports computational vaccinology and maternal-fetal health analytics.*

Biomedical AI, Causal Inference & Data-Driven Biological Modeling

- [Bi] Data-driven learning how oncogenic gene expression locally alters heterocellular network. (with D. J. Klinken II, A. Fernandez, W. Deng, A. C. Pirkey). *Nature Communications*, 13(1), 1–15, 2022. ♦ *Tissue-scale interaction modeling in tumor microenvironments; supports multi-omics analysis linking molecular signaling to immune-microenvironment phenotyping and computational immunology.*
- [Bii] BaMANI: Bayesian Multi-Algorithm Causal Network Inference. (with A. C. Pirkey, A. Gould, D. J. Klinken II). *arXiv preprint arXiv:2508.11741*, 2025. ♦ *An ensemble pipeline for causal-structure learning from heterogeneous biomedical signals with graph-level uncertainty; provides a methodological foundation for future uncertainty-aware causal phenotyping in perioperative and clinical-AI applications.*

Foundational Methods: Scientific Computing, Simulation & Numerical Analysis (selected; 19 peer-reviewed articles)

- [Fi] A general numerical algorithm for nonlinear differential equations by the variational iteration method. (with J. H. He). *Journal of Numerical Methods for Heat & Fluid Flow*, 30(11): 797–810, 2020.
- [Fii] An Optimal Choice of Initial Solutions in the Homotopy Perturbation Method. (with E. Hesameddini). *Journal of Nonlinear Sciences and Numerical Simulation*, 10(10): 1389–1398, 2009.

♦ **Plus 17 additional peer-reviewed articles in computational mathematics and nonlinear dynamical systems model development, several MathSciNet-indexed. Full list available on [Google Scholar](#).**

Invited Talks & Conference Presentations (selected from 10 conferences)

- *Cross-Species Immune-Cell Mapping via OT-RMC for CMV Vaccine Research*, **Invited Speaker**, Duke Center for Human Systems Immunology (CHSI) & Multiscale Immune Systems Modeling (MISM) Center of Excellence, May 2026.
- *Data-Driven Modeling for Inferring Key Protein Impact on Cell-to-Cell Networks and Tissue Microenvironment Dynamics in Human Breast Cancer*. **Invited Speaker**, BridgesDigital Health NRT Trainee/Fellow Research Program, WVU, Oct 2023.
- *Decoding Tumor Microenvironments: Data Augmentation and Deep Learning in Cancer Cell Deconvolution*. Great Lakes Breast Cancer Symposium, 2023.
- *Data-driven learning how oncogenic gene expression locally alters heterocellular networks*. Joint Mathematics Meetings, Seattle, April 6–9, 2022.

Funding and Fellowships

- **NIH/NIAID R01 AI173333**, joint NIH-funded project with Weill Cornell Medicine and Duke Biostatistics & Bioinformatics, “Identifying and modeling immune correlates of protection against congenital CMV transmission after primary maternal infection.” Named personnel and postdoctoral researcher leading the computational modeling component for in-silico vaccine-efficacy analysis and maternal-fetal immune analytics using multiscale scientific machine learning (2024–Present).
- **NSF NRT Fellow (BridgesDH)**, NSF NRT Award #2125872, “BridgesDH — Bridges to Digital Health National Research Traineeship,” West Virginia University. Two-year, stipend-bearing graduate fellowship in AI & Machine Learning for Digital Health (2023–2024);

Awards & Honors

- › **NSF Advanced Certificate** in Machine Learning & Data Science for Digital Health (2026).
- › **2025 Excellent Editor Award**, IJMSSC (World Scientific) for sustained editorial leadership in modeling, simulation, and scientific computing.
- › **NSF NRT Fellowship (BridgesDH, Award #2125872)** — two-year, stipend-bearing graduate traineeship in AI & Machine Learning for Digital Health, West Virginia University (2023–2024).
- › **Graduate Summer Machine Learning Research Fellowship**, SMDS, Eberly College of Arts & Sciences, WVU (2023).
- › **AMS Travel Grant Award**, AMS Sectional Meeting, University of Cincinnati (April 2023).
- › **MDS22 Travel Award**, SIAM Conference on Mathematics of Data Science, California (Sep 2022).
- › **JMM Travel Award**, AMS Joint Mathematics Meetings (2022).
- › **Travel Award**, School of Mathematical Data Sciences, WVU (2021).
- › **Graduate Student Travel Grant**, Eberly College of Arts & Sciences and Provost's Office, WVU (2020).
- › **Best Paper Award & Excellence in Graduate Research Award**, Shiraz University of Technology (2017).
- › **Exceptional Talented Student Award**, Shiraz University of Technology (2010).

Editorial, Advisory & Peer-Review Roles

- › **Editorial Board Member**, *npj Digital Medicine* (Nature Portfolio) (2026 – Present).
- › **Data & Statistical Advisory Board**, *iScience* (Cell Press) (2026–2028).
- › **Guest Editor**, Special Issue “Statistical Analysis in Bioinformatics: Theory and Application,” *Mathematics* (MDPI) (2026).
- › **Chair**, Joint Mathematics Meetings, Contributed Papers Sessions on *Mathematical Modelling in Biology and Epidemiology* — American Mathematical Society (2022).
- › **Editorial Board Member** — *Journal of Modeling, Simulation, and Scientific Computing* (2020 – Present).
- › **Peer Reviewer** (50+ manuscripts): *Nature Medicine*, *Nature Communications*, *Journal for ImmunoTherapy of Cancer* (JITC), American Conference on Pharmacometrics (ISoP); Neural Information Processing Systems (NeurIPS) and computational/applied-math, AI, and ML journals (Wiley, Taylor & Francis, Springer, Elsevier).

Mentoring, Advising & Outreach

- › **Trainee Mentor & Hackathon Co-Organizer**, Multiscale Immune Systems Modeling (MISM) Center of Excellence Summer Trainee Program, Duke, Summer 2026 — supported hackathon coordination and the design of an agent-based modeling / infection-dynamics challenge for an NIH-funded immunology multiscale-modeling training cohort; advised on simulation data structure, parameter identifiability, code review, and intern-facing challenge design.
- › **External Graduate Student Panelist**, NSF Research Experiences for Undergraduates (REU): *Discrete and Continuous Analysis in Appalachia*, Fairmont State University (Summer 2022).
- › **Invited Graduate Judge**, 5th Annual Fall and 7th Annual Spring Undergraduate Research Symposia (oral and poster presentations), West Virginia University (2022 and 2023).
- › **President & Founder**, WVU SIAM Student Chapter — Society for Industrial and Applied Mathematics (2022–2024).
- › **Mentored three M.Sc. students** through thesis research at Shiraz University of Technology, 2010–2014.

Teaching

- | | |
|---|-------------|
| Lecturer / Teaching Instructor · WVU — School of Mathematical & Data Sciences | 2018 – 2021 |
| › Algebra with Applications — Teaching Instructor, Fall 2021.
› Multivariable Calculus — Assistant, Spring 2021.
› Applied Linear Algebra — Assistant, Spring 2020.
› Advanced Linear Algebra — Assistant, Fall 2018.
› Numerical Analysis (MATH 521) — Assistant, Spring 2019.
› Engineers Calculus (MATH 455E) — Recitation Leader, Fall 2018. | |
| Lecturer / Teaching Assistant · Shiraz University of Technology | 2009 – 2010 |

- › **Advanced Engineering Mathematics** — Instructor, Spring 2009.
- › **Differential Equations** — Assistant, Fall 2008.

Press Coverage

Press coverage of research on scalable data-driven optimization, computational approaches to reducing drug costs, and how oncogenic gene expression alters heterocellular networks included a EurekAlert!/AAAS release, TechLive, Genetic Engineering & Biotechnology News, and WVU's internal press (2022).

Professional Affiliations

- › **Multiscale Immune Systems Modeling (MISM) Center of Excellence** — Research Collaborator, 2025 – Present.
- › **Duke Center for Human Systems Immunology (CHSI)** — Research Collaborator, 2024 – Present
- › **Society for Immunotherapy of Cancer (SITC)** — Member, 2022 – Present.
- › **American Association for Cancer Research (AACR)** — Member, 2021 – Present.
- › **Society for Mathematical Biology** — Member, 2021 – Present.
- › **American Mathematical Society (AMS)** — Member, 2017 – Present.
- › **Conference & Scientific Committee Service** — multiple national & international applied-math conferences (2019–2025).

Technical Proficiencies

Machine Learning & AI (clinical & biomedical analytics emphasis). Neural Networks Deep Learning (CNNs)
 Transformers LLMs & NLP Fine-Tuning (SFT, LoRA) Retrieval-Augmented Generation (RAG)
 Variational Autoencoders (VAEs) Wasserstein GANs (WGAN-GP) Supervised, Unsupervised & Reinforcement Learning
 Random Forest / Gradient Boosting Hyperparameter Optimization Cross-Validation & Calibration

Reproducibility & Clinical-AI Governance. Conformal Prediction Uncertainty Quantification Sensitivity Analysis
 Subgroup Performance Auditing Bias & Fairness Audits Reproducible Pipelines (Containerized HPC)

Bayesian Inference & Causal Modeling. Bayesian Networks Causal Graph Analysis PyMC DoWhy
 bnlearn Markov Chain Monte Carlo (MCMC) TETRAD causalnex

Statistical Modeling & Inference. Time-Series Forecasting Survival Analysis Hypothesis Testing Causal Inference
 Bayesian Statistics A/B Testing

Scientific Computing & Multiscale Modeling. Neural ODEs Gaussian-Process Surrogates Optimal Transport
 Agent-Based Models ODE / SDE Modeling Spectral / Finite-Element Methods

High-Performance & Distributed Computing. HPC Clusters CPU / GPU Arrays PyTorch Distributed Data Parallel

Frameworks & Libraries. PyTorch TensorFlow Hugging Face (transformers, datasets) scikit-learn

Programming Languages & Tools. Python R SQL MATLAB Git / GitHub Docker