

Academic Appointments & Research Roles

- **Visiting Scholar & Project Co-Investigator** · Massachusetts Institute of Technology 2026 – 2027
Laboratory for Computational Physiology, MIT Critical Data
- **Lead Data Scientist & Biostatistician** · Duke University 2026 – 2027
Duke Comprehensive Epilepsy Center and Department of Neurology, Epilepsy Surgery Outcomes Project
- **Postdoctoral Associate** · Duke University 2024 – 2026
Department of Biostatistics & Bioinformatics
- **NSF NRT Research Fellow in AI & Machine Learning** · National Science Foundation 2023 – 2024
Bridges to Digital Health National Research Traineeship, Award #2125872

Education & Professional Training

- **Ph.D., Applied Mathematics** · West Virginia University 2017 – 2024
Dissertation: Developing a Data-Driven Method for Inferring Heterocellular Networks in Cancer
- **NSF Advanced Certificate** · National Science Foundation 2026
AI & Machine Learning for Digital Health
- **M.Sc. and B.Sc., Applied Mathematics, with honors** · Iran 2010, 2007

Clinical research training: CITI Program certifications in Human Subjects Research, Good Clinical Practice, and HIPAA and Clinical Data Privacy, completed through Duke Health, 2026.

Research Interests

Trustworthy Clinical AI, Surgical & High-Acuity Decision Support, Multimodal Health Data, Single-Cell & Immune Multiomics, Causal Inference & Uncertainty Quantification

Selected Research Contributions

- **Visiting Scholar & Project Co-Investigator** · Massachusetts Institute of Technology 2026 – 2027
Laboratory for Computational Physiology, MIT Critical Data
- **Reliability and patient-safety evaluation of clinical AI.** Evaluate deep-learning diagnostic-imaging architectures, including convolutional neural networks, vision transformers, and hybrid models, for multi-task classification. Quantify image-level error accumulation through a consensus-based harm score that identifies examinations and patients most vulnerable to model failure.
- **Multimodal vulnerability and high-acuity care phenotyping.** Link imaging-model harm scores to ICU care phenotypes using encounter-level alignment of MIMIC-IV electronic health records and MIMIC-CXR radiographs. Build reproducible pipelines for calibration, uncertainty quantification, severity and threshold sensitivity, and subgroup and fairness auditing, with causal framing to examine whether vulnerable patients share clinical or care-delivery patterns.
- **Lead Data Scientist & Biostatistician** · Duke University 2026 – 2027
Duke Comprehensive Epilepsy Center and Department of Neurology, Epilepsy Surgery Outcomes Project
- **Surgical decision support and outcome prediction.** Lead the statistical design and reproducible analysis for a temporal-lobe-epilepsy study evaluating whether the SEEG-derived 5-SENSE focality score predicts postoperative seizure freedom. Assess discrimination, sensitivity and specificity, predictive values, ROC/AUC with bootstrap confidence intervals, calibration, and clinically meaningful thresholds across resection, laser interstitial thermal therapy (LITT), and neuromodulation.

- **Failure analysis and subgroup interpretation.** Investigate why some high-score patients do not achieve the expected outcome using histology and imaging-concordance variables, Fisher and penalized-logistic models, structural-missingness handling, and prespecified sensitivity analyses. The aim is to identify when the score may inform patient selection and treatment counseling and where its limitations should constrain use.

■ **Postdoctoral Associate** · Duke University, Department of Biostatistics & Bioinformatics 2024 – 2026
Joint NIH-funded Duke–Weill Cornell Medicine, congenital CMV (cytomegalovirus) collaboration

- **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-species biomedical data harmonization.** Build quality-controlled pipelines for batch correction, feature engineering, clustering, and cell-population alignment using optimal transport with relaxed marginals, Gaussian-mixture representations, Leiden clustering, and Wasserstein-based distances. Containerize workflows with Docker and scale analyses on SLURM/HPC systems.

■ **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. 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 AI 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.

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

Manuscripts in Preparation

- [Mi] Preoperative Focality Scoring for Predicting Seizure Freedom After Temporal-Lobe Epilepsy Surgery. *Statistical and data-science lead; clinical collaboration with the Duke Comprehensive Epilepsy Center & Department of Neurology.* ♦ *Diagnostic-performance and causal-explanatory modeling of an SEEG-derived focality score for epilepsy-surgery outcomes; subgroup analysis and principled structural-missingness handling across resective surgery, laser ablation (LITT), and neuromodulation cohorts* (Manuscript completion August 2026).
- [Mii] 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).* ♦ *Methods manuscript on reproducible cross-species alignment of flow-cytometry measurements via probabilistic optimal transport; supports standardized biomedical data integration, transferable inference, and robust analytical pipelines applicable to multi-site clinical-data harmonization* (Manuscript completion August 2026).
- [Miii] 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).* ♦ *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* (Manuscript completion October 2026).

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. ♦ *Open release of an ensemble pipeline for relational mechanistic discovery from heterogeneous biomedical signals; supports prediction, calibration, and uncertainty quantification in perioperative analytics and clinical AI.*

Foundational Methods: Scientific Computing, Simulation & Numerical Analysis (selected from 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.

♦ **Seventeen additional peer-reviewed articles in computational mathematics and nonlinear dynamical systems modeling are included in my [Google Scholar profile](#).**

Research Support & Fellowships

- **NIH/NIAID R01 AI173333**, “Identifying and modeling immune correlates of protection against congenital CMV transmission after primary maternal infection.” Named personnel and postdoctoral researcher on a joint Weill Cornell Medicine–Duke project, leading computational modeling for in-silico vaccine-efficacy and maternal–fetal immune analyses using multiscale scientific machine learning (2024–Present).
- **NSF NRT Fellowship, Bridges to Digital Health**, Award #2125872. Two-year, stipend-bearing graduate fellowship in AI and machine learning for digital health, West Virginia University (2023–2024).

Awards & Honors

- **2025 Excellent Editor Award**, *International Journal of Modeling, Simulation, and Scientific Computing* (World Scientific), 2025.
- **NSF Advanced Certificate in Machine Learning & Data Science for Digital Health**, 2026.
- **NSF NRT Fellowship** in AI & Machine Learning for Digital Health, West Virginia University, 2023–2024.
- **Graduate Summer Machine Learning Research Fellowship**, West Virginia University, 2023.
- **AMS Travel Grant Award**, American Mathematical Society Sectional Meeting, 2023.
- **MDS22 Travel Award**, SIAM Conference on Mathematics of Data Science, 2022.
- **JMM Travel Award**, Joint Mathematics Meetings, 2022.
- **Graduate Student Travel Awards**, West Virginia University, 2022 and 2023.
- **Best Paper Award and Excellence in Graduate Research Award**, Shiraz University of Technology, 2017.
- **Exceptional Talented Student Award**, Shiraz University of Technology, 2010.

Editorial, Advisory & Peer-Review Service

Editorial & Advisory Boards

- **Editorial Board Member**, *npj Digital Medicine* (Nature Portfolio), 2026–Present.
- **Data & Statistical Advisory Board**, *iScience* (Cell Press), 2026–2028.
- **Editorial Board Member**, *International Journal of Modeling, Simulation, and Scientific Computing* (World Scientific), 2020–Present.

Reviewing & Other Editorial Service

- **Session Chair**, Joint Mathematics Meetings contributed-paper sessions on *Mathematical Modelling in Biology and Epidemiology*, American Mathematical Society, 2022.
- **Peer Reviewer** for 50+ manuscripts, including *Nature Medicine*, *Nature Communications*, *Journal for ImmunoTherapy of Cancer*, the American Conference on Pharmacometrics, NeurIPS, and computational, applied-mathematics, AI, and machine-learning journals.

Invited Talks & Conference Presentations *(selected)*

- *Cross-Species Immune-Cell Mapping via OT-RMC for CMV Vaccine Research*, invited speaker, Duke Center for Human Systems Immunology and Multiscale Immune Systems Modeling 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, NSF Bridges to Digital Health NRT Program, West Virginia University, October 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 2022.

Mentoring, Advising & Outreach

- **Trainee Mentor & Hackathon Co-Organizer**, Multiscale Immune Systems Modeling Center of Excellence Summer Trainee Program, Duke, Summer 2026. Helped design an agent-based infection-dynamics challenge and advised trainees on simulation data structure, parameter identifiability, code review, and challenge implementation.

- **External Graduate Student Panelist**, NSF Research Experiences for Undergraduates program, Fairmont State University, Summer 2022.
- **Invited Graduate Judge**, West Virginia University Undergraduate Research Symposia, 2022 and 2023.
- **Founder and President**, West Virginia University Society for Industrial and Applied Mathematics (SIAM) Student Chapter, 2022–2024.
- **Mentor to three M.Sc. students**, Shiraz University of Technology, 2014.

Teaching

- **Lecturer / Teaching Instructor** · West Virginia University 2018 – 2021
 - Teaching Instructor, **Algebra with Applications** (Fall 2021); recitation leader, **Engineers Calculus** (Fall 2018).
 - Teaching Assistant, **Multivariable Calculus** (Spring 2021), **Applied Linear Algebra** (Spring 2020), **Numerical Analysis** (Spring 2019), and **Advanced Linear Algebra** (Fall 2018).
- **Lecturer / Teaching Assistant** · Shiraz University of Technology 2009 – 2010
 - Instructor, **Advanced Engineering Mathematics** (Spring 2009); Teaching Assistant, **Differential Equations** (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.

Technical Proficiencies

Clinical & Surgical AI Evaluation.

Diagnostic Performance

ROC/AUC & Bootstrap CIs

Calibration

Threshold Analysis

Uncertainty Quantification

Subgroup & Fairness Auditing

Sensitivity Analysis

Causal & Statistical Modeling.

Causal Inference

Bayesian Networks

MCMC

Penalized Regression

Survival Analysis

Hypothesis Testing

Structural-Missingness Analysis

Machine Learning & Multimodal Analytics.

CNNs

Vision Transformers

Transformers & NLP

VAEs

WGAN-GP

Random Forest / Gradient Boosting

Cross-Validation

EHR–Imaging Integration

Scientific Computing & Mechanistic Modeling.

Optimal Transport

Neural ODEs

Gaussian-Process Surrogates

Physics-Informed Neural Networks

Agent-Based Models

Spectral / Finite-Element Methods

ODE / SDE Modeling

Programming, Frameworks & Reproducibility.

Python

R

SQL

MATLAB

PyTorch

TensorFlow

scikit-learn

PyMC

DoWhy

Git / GitHub

Docker

SLURM / HPC