

Fatemeh Jafarabadi

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PROFESSIONAL SUMMARY

BIOMEDICAL ENGINEER | SIMULATION & DATA SCIENCE

Ph.D. Biomedical Engineer with a strong foundation in computational modeling, multiphysics simulation, and experimental research. Experienced in developing and validating mechanistic models that couple structural, fluid, and biological phenomena, with applications spanning soft tissue mechanics, neurological injury, and bioprocess analytics. Adept at integrating experimental datasets with high-fidelity simulations to extract quantitative biomarkers and drive scientific insight. Skilled in end-to-end research workflows — from study design and parametric modeling to data analysis, scientific writing, and cross-functional collaboration — with outcomes including peer-reviewed publications and a provisional patent. Effective communicator of complex technical content to both scientific and non-technical audiences. **Languages:** English (Fluent), Persian (Native), Turkish (Beginner).

Multiphysics Simulation | Finite Element Analysis (FEA) | Nonlinear Solid Mechanics | Computational Modeling | Soft Tissue Mechanics | Mechanistic & Data-Driven Modeling | Parameter Calibration | Experimental Validation | High-Dimensional Data Analysis | Multivariate Analysis (PCA, PLS) | Machine Learning & Predictive Modeling | Python (NumPy, SciPy, Pandas, Scikit-learn) | MATLAB | R | FORTRAN | ABAQUS | Design of Experiments | Cross-Functional Collaboration | Project Management

PROFESSIONAL EXPERIENCE

UNIVERSITY OF NOTRE DAME, Notre Dame, IN

01/2023 - 05/2026

Graduate Research Assistant (CoMMaND Lab): Mechanics of Inflammatory Swelling

- Designed and executed a longitudinal closed-head TBI mouse study (N=40), writing the full IACUC protocol and managing all experimental phases; integrated multimodal biological datasets, including 60+ quantitative MRI scans, 150+ immunofluorescence images, and 300+ biomechanical simulations, to derive spatial and temporal biomarkers and quantify injury progression across four time points, resulting in two first-author publications.
- Solved an inverse problem integrating ex vivo datasets with a multiphase mechanistic model in Abaqus by implementing a differential evolution optimization framework; validated predictions against experimental measurements across multiple time-points, demonstrating model robustness under real-world variability.
- Built a custom multiphase subroutine in Abaqus (UEL) coupling fluid pressure, solid displacement, and cell density dynamics to simulate tissue injury progression across spatial and temporal scales; achieved 85% correlation with experimental data across multiple biological conditions.

REGENERON PHARMACEUTICALS INC., Tarrytown, NY

06/2025 - 12/2025

Data Science Co-Op, R&D Sciences: A Novel Algorithm for Raman Spectra Platform Models

- Validated a novel multivariate modeling framework across the full bioprocess pipeline, bioreactor scale-up, purification, and formulation, demonstrating robustness under batch-to-batch variability and varying biological conditions; enabled consistent quantification of 20+ analytes across complex sample matrices using a single unified production pipeline.
- Developed the underlying multivariate framework for high-dimensional Raman spectroscopy time-series data, improving prediction accuracy from 60% to 90% over standard PLS methods by implementing algorithms to reduce biological confounding factors; the approach is documented in a provisional patent (pending).
- Built production-ready Python tools using version-controlled, reproducible workflows to integrate the modeling framework into existing analytical pipelines, enabling scalable deployment across R&D; collaborated with cross-functional scientists and process engineers to support data-driven decision-making across the drug development pipeline.

UNIVERSITY OF NOTRE DAME, Notre Dame, IN

Graduate Research Assistant (CoMMaND Lab): Instabilities in Soft Layered Materials

02/2021 - 12/2022

- Developed a modeling framework in Abaqus using a custom subroutine (VUMAT) to simulate CSF-brain surface interactions and cortical growth dynamics, coupling non-linear hyperelastic deformations with bilayer stability analysis to investigate mechanistic drivers of brain morphology.
- Automated a parametric study of 100+ Abaqus simulations to quantify morphological instabilities across biological conditions, identifying a 28% decrease in critical strain for whole-domain compression and a 13% reduction for film growth mode, demonstrating how systematic computational approaches can extract meaningful physiological signals from high-dimensional parameter spaces.
- Characterized dynamic changes in cortical film thickness, wave patterns, and folding modes (gyri and sulci) as a function of varying surface pressure, deriving quantitative biomarkers of brain structural evolution across simulated physiological states.

Graduate Research Assistant (CoMMaND Lab): Tumor Growth Modeling

02/2022 - 10/2022

- Developed a tri-phasic framework in Abaqus (UEL) to model tissue-to-tumor transformation dynamics, coupling solid tissue mechanics with evolving cell population densities to simulate disease progression, contributing to the modeling section of a multi-institutional U01 NIH grant proposal spanning a 5-year scope.
- Supervised an undergraduate researcher in the volumetric segmentation of 10 clinical MRI scans, generating high-fidelity 3D datasets used to calibrate and validate initial tumor growth trajectories against real patient imaging data.

Graduate Research Assistant (CoMMaND Lab): Local Cortical Thickness Patterns

02/2022 - 10/2022

- Benchmarked and optimized five MRI segmentation pipelines (FSL, ANTs, Segmentator, and custom Python scripts) to process the analysis of non-human primate cerebral cortices using high-resolution magnetic resonance imaging.
- Applied advanced image segmentation algorithms to quantify cortical thickness variations across gyral and sulcal regions, deriving spatial biomarkers of cortical folding patterns from high-dimensional imaging datasets.

Undergraduate Research Assistant

- Developed a mathematical modeling framework to simulate the mechanical response of soft hyperelastic biological materials under nanoindentation, capturing complex nonlinear behavior across diverse loading conditions.
- Built and validated computational pipelines using Python scripting and custom subroutines (UMAT) to characterize soft tissue mechanical properties, generating calibrated predictions of large-deformation behavior validated against experimental measurements across multiple material configurations.

TECHNICAL SKILLS

Programming & Tools

- ABAQUS CAE, Python (Scikit-learn, NumPy, Pandas, SciPy, matplotlib, seaborn), R, MATLAB, FORTRAN, Dataiku, JMP, COMSOL Multiphysics, SolidWorks

Modeling & Analytics

- Finite Element Analysis, Nonlinear Solid Mechanics, Mechanistic Modeling, Parameter Calibration, Machine Learning, Predictive Modeling, Multivariate Analysis (PCA, PLS), Chemometric Modeling (Raman/PAT), High-Dimensional Data Processing, Design of Experiments

Laboratory Skills

- Quantitative In-vivo MRI, Multi-channel Immunofluorescence, Image Preprocessing (ImageJ), Segmentation (Slicer), Microscopy

EDUCATION

UNIVERSITY OF NOTRE DAME, Notre Dame, IN

2026

Doctor of Philosophy (Ph.D.) in Biomedical EngineeringDissertation: *Investigating the Role of Mechanics in Soft Tissue Growth and Injury Using Mathematical and Experimental Approaches.*

UNIVERSITY OF NOTRE DAME, Notre Dame, IN

2024

Masters of Science (M.S.) in Mechanical Engineering

TEHRAN POLYTECHNIC, Tehran, IR

2019

Bachelor of Science (B.S.) in Mechanical EngineeringDissertation: *Computational Modeling of the Nanoindentation Test on Soft Elastic Materials Using FEM Techniques.*

JOURNAL PUBLICATIONS

Peer-reviewed Papers

- **Jafarabadi, F.**, Rumbach R., Datta, M., Holland, M. A., "Experimentally calibrated poro-hyperelastic model of brain injury reveals astrocyte-driven edema formation." (Submitted).
- **Jafarabadi, F.**, Datta, M., Holland, M. A., "Mechanisms of inflammatory response in secondary brain injury: a review of computational approaches, challenges, and future directions," *Journal of Biomechanics and Modeling in Mechanobiology* (2026), <https://doi.org/10.1007/s10237-026-02074-6>.
- Demirci, N., **Jafarabadi, F.**, Wang, X., Wang, Sh., Holland, M. A., "Consistency and variation in the placement of cortical folds: a perspective," *Journal of Brain Multiphysics* (2023), <https://doi.org/10.1016/j.brain.2023.100080>.
- **Jafarabadi, F.**, Wang, Sh., Holland, M. A., "A numerical study on the influence of cerebrospinal fluid pressure on brain folding," *Journal of Applied Mechanics* (2023), <https://doi.org/10.1115/1.4057020>.

PROFESSIONAL PRESENTATIONS

Presentations & Posters

- **Jafarabadi, F.**, Mudiraj, Sh., "A Novel Algorithm for Raman Spectra Modeling to Enable Platform Models," *Regeneron Pharmaceuticals Inc. Cross-Departmental Co-op Project Presentation* - Tarrytown, NY, Oct 2025.
- **Jafarabadi, F.**, Holland, M. A., "A Poroelastic Approach for Modeling Tissue Inflammatory Swelling," *Biomedical Engineering Society Conference* - Baltimore, MD, Oct 2024.
- **Jafarabadi, F.**, Holland, M. A., "A Poroelastic Approach for Modeling Tissue Swelling in Brain Injuries," *GradSWE End-of-Year Symposium* - Notre Dame, IN, May 2024.
- **Jafarabadi, F.**, Holland, M. A., "The mechanics of inflammatory swelling in brain," *Indiana Science Policy Day* - Indianapolis, IN, Feb 2024.
- **Jafarabadi, F.**, Holland, M. A., "A poroelastic approach for modeling tissue swelling," *Bioengineering Graduate Program Seminar Series* - University of Notre Dame, Jan 2024.
- **Jafarabadi, F.**, Holland, M. A., "A poroelastic approach for modeling tissue swelling," *Bioengineering Graduate Program Seminar Series* - University of Notre Dame, July 2023.
- **Jafarabadi, F.**, Holland, M. A., "Instability of bilayer systems with surface pressure; the influence of cerebrospinal fluid pressure on brain folding," *Prospective Bio-engineering Graduate Student Recruitment Event* - University of Notre Dame, Apr 2023.
- **Jafarabadi, F.**, Holland, M. A., "Instability of bilayer systems with surface pressure; influence of cerebrospinal fluid pressure on brain folding," *Bioengineering Graduate Program Seminar Series* - University of Notre Dame, Sep 2022.
- **Jafarabadi, F.**, Holland, M. A., "Computational modeling of brain bilayer under cerebrospinal fluid pressure," *Summer Biomechanics, Bioengineering, and Biotransport Conference* - Baltimore, MD, Jun 2022.
- **Jafarabadi, F.**, Holland, M. A., "Instability of bilayer systems with surface pressure; influence of cerebrospinal fluid pressure on brain folding," *Bioengineering Graduate Program Seminar Series* - University of Notre Dame, Apr 2022.
- **Jafarabadi, F.**, Holland, M. A., "Instability of bilayer systems with surface pressure: the effect of cerebrospinal fluid on brain instability," *American Physical Society Conference* - Chicago, IL, Mar 2022.

HONORS & AWARDS

UNIVERSITY OF NOTRE DAME

- Precision Medicine Research Fellowship (03/2025)
- Notebaert Professional Development Award (06/2022 & 08/2024)
- Graduate School Professional Development Award (08/2023 & 08/2024)
- Leadership Socially Engaged Research Fellowship (08/2023)
- Aerospace & Mechanical Engineering Department First Year Fellowship (02/2021)

TEACHING EXPERIENCE

UNIVERSITY OF NOTRE DAME

02/2021 - 12/2024

Graduate Teaching Assistant

- AME 20241: Mechanics of Solids
- CE 20150: Mechanics 1
- AME 30315: Differential Equations, Vibrations, and Control
- AME 40572: Introduction to Biomechanics

PROFESSIONAL ASSOCIATIONS

SOCIETY OF WOMEN ENGINEERS (SWE)

10/2021 - Present

Professional Member & Judge

- Served as a technical judge for 50+ applications across national and local categories, including the Mission Award, Scholarship Review, and Global Leadership Award.

SWE LEADERSHIP DEVELOPMENT PROGRAM (LDP)

08/2024 - 05/2026

Participant, Beginner & Advanced Track

- Selected from 100+ applicants to complete a competitive leadership curriculum focused on personal growth, strategic professional development, and mentorship.

EXPANDING YOUR HORIZONS NETWORK

06/2024 - 05/2025

Vice President & Workshop Leader

- Directed a day-long STEM conference and led 10 hands-on workshop sessions for 80+ middle school students to promote diversity and female representation in engineering.

BOOK CLUB at NOTRE DAME

06/2024 - 05/2025

President

- Organized monthly meetings with a curated selection of one book per month. Increased membership by 20% by fostering an inclusive intellectual environment that encouraged critical thinking and cross-cultural understanding.

ASSOCIATION OF WOMEN IN SCIENCE (AWIS)

09/2024 - 04/2025

Mentor

- Guided and supported an undergraduate student in STEM, providing mentorship on academic and professional development.

COLLEGE OF SCIENCE JOINT ANNUAL MEETING at NOTRE DAME

05/2024 & 05/2025

Engineering Judge

- Judged presentations by the College of Engineering undergraduate students for the Best Presentation Awards (11 posters).

SUMMER BIOENGINEERING CONFERENCE

02/2025 & 06/2023 & 03/2024

Engineering Judge

- General Abstract (6 abstracts).
- ASME-BED BS-Level Student Paper Competition (5 abstracts).
- ASME-BED BS-Level Student Paper Competition (3 posters).

AEROSPACE AND MECHANICAL ENGINEERING GRADUATE ORGANIZATION

04/2022 - 05/2025

Vice President & Social Chair

- Coordinated 10 annual social and professional development events, fostering community engagement and providing academic support through structured exam preparation sessions.

LEADERSHIP ADVANCING SOCIALLY ENGAGED RESEARCH PROGRAM (LASER)

08/2023 - 07/2024

Participant

- Orchestrated a yearlong initiative within the Graduate Society of Women Engineers to expand industry partnerships and mentorship; designed and facilitated a strategic leadership workshop for 16 participants on goal-setting and inclusive organizational development.

GRADUATE STUDENT GOVERNMENT (GSG)

01/2023 - 05/2024

Social Chair

- Organized 20+ diverse social and cultural events, including sports competitions and themed dinners, to enhance the graduate student experience across the university.

GRADUATE SOCIETY OF WOMEN ENGINEERS (GRADSWE)

06/2022 - 05/2024

Vice President & Professional Chair

- Managed organizational budgets and supervised 6 major workshops and a research symposium for 30+ participants; engaged 11 professional presenters to support 100+ scholars.

NORTHERN INDIANA REGIONAL SCIENCE & ENGINEERING FAIR

02/2025 & 03/2023 & 03/2024

Engineering Judge

- Elementary Physical Sciences Project Hoffman Award (28 applications).
- Elementary Division (35 applications).
- Senior Division Award (12 applications).

ANNUAL BRAIN AWARENESS FAIR

04/2024

Workshop Leader

- Organized a 2-hour workshop with hands-on activities for 10 groups of attendees to foster public enthusiasm for understanding STEM disciplines.

JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS

02/2024

Reviewer

- Assisted PI in reviewing a scholarly article and evaluating the manuscript's content, methodology, and findings for scientific accuracy and novelty.