Zan Ahmad

Department of Applied Mathematics & Statistics

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Research Interests

Neural Operators, Manifold Learning, Riemannian Shape Analysis, Cardiovascular Modeling, Mathematical Biology

Education

Johns Hopkins University Whiting School of Engineering — Baltimore, MD

Ph.D. Candidate, Applied Mathematics & Statistics — June 2022 - Dec 2026

Advisors: Natalia Trayanova, Mauro Maggioni

Topic: *Neural Operators for Accelerating Cardiovascular Modeling*

M.S.E., Applied Mathematics & Statistics — June 2022 - May 2025

Advisor: Mauro Maggioni

Topic: *Enforcing Symmetries in Diffeomorphic Operator Learning for Partial Differential Equations*

New York University Courant Institute of Mathematical Sciences — New York, NY

B.A., Mathematics (Honors) — Sept 2017 - Dec 2020

Minors: Chemistry, Film Production

Advisors: Charles S. Peskin, Charles Puelz

Research Experience

Johns Hopkins University, Institute of Computational Medicine — Baltimore, MD

Graduate Researcher in *Computational Cardiology Lab* — June 2022 - Present

Advisors: Natalia Trayanova, Mauro Maggioni

Yale School of Medicine, Neurology Department — New Haven, CT

Postgraduate Researcher in *Blumenfeld Lab* — June 2021 - May 2022

Advisor: Hal Blumenfeld

New York University, Center for Neural Science, — New York, NY

Training Program in Computational Neuroscience — Sept 2020 - May 2021

Advisor: Charles S. Peskin

New York University, Courant Institute of Mathematical Sciences — New York, NY

Applied Mathematics Summer Undergraduate Research Experience — June 2020 - Aug 2020

Advisors: Charles Puelz, Charles S. Peskin

New York University, Courant Institute of Mathematical Sciences — New York, NY

Modeling & Simulation Research Training Group — Sept 2019 - May 2020

Advisor: Charles Puelz

New York University, Department of Chemistry — New York, NY

Undergraduate Researcher in *DNA Nanotechnology Lab* — January 2018 - August 2019

Advisors: Nadrian Seeman, Yoel P. Ohayon

Papers and Preprints

1. "Graph Fourier Neural Kernels (G-FuNK): Learning Solution Generators of of Nonlinear Diffusive PDEs on Multiple Domains."

S. Loeffler, **Z. Ahmad**, ..., N.Trayanova, M. Maggioni.
arXiv Preprint, under review ICLR 2025

2. "Elastic shape analysis for unsupervised clustering of left atral appendage geometries in atrial fibrillation patients."
Z. Ahmad, M. Yin, Y. Sukurdeep, N. Rotenberg, E. Kholmovski, N. Trayanova.
arXiv preprint

3. "A comprehensive stroke risk assessment by combining atrial computational fluid dynamics simulations and functional patient data."
A. Zingaro, **Z. Ahmad**, E. Kholmovski, K. Sakata, A. Morris, L. Dede', A. Quarteroni, N. Trayanova.
Journal of Scientific Reports – invitation to collection titled "Computational Fluid Dynamics for the Study of Cardiovascular Disease".

4. "Optimal fenestration of the Fontan circulation."
Z. Ahmad, L.H. Jin, D.J. Penny, C. Rusin, C.S. Peskin, C. Puelz.
Frontiers in Physiology - Computational Physiology and Medicine, 13, 2022.

5. "Steady-state analysis of gravitational effects on hemodynamics"
Z. Ahmad, A. Kennard, R.S. Blue, C.S. Peskin, K.M. Ong.
in prep, Journal of Scientific Reports.

6. "Enforcing symmetries in diffeomorphic operator learning for partial differential equations"
Z. Ahmad, S. Chen, M. Yin, N. Charon, N.Trayanova, M. Maggioni.
in prep, AAAI 2025 Workshop on AI for Accelerating Science in Engineering

7. "Learning temporal dynamics of diffusive PDEs on varying physiological branched network geometries."
Z. Ahmad, S. Loeffler, N.Trayanova, M. Maggioni.
in prep, AAAI 2025 Workshop on AI for Accelerating Science in Engineering

8. "Diffeomorphic operator learning for 3D vector-valued PDEs with known symmetries"
Z. Ahmad, S. Chen, Y. Du, M. Yin, N. Charon, N.Trayanova, M. Maggioni.
in prep, ICML 2025

Conference Presentations

1. "Mathematical Cardiology: Operator Learning, Shape Analysis and Computational Fluid Dynamics."
IEEE Engineering in Medicine and Biology Leadership Academy Workshop on AI/Datascience in Medicine and Healthcare, Chania, Crete, Greece June 2024.

2. "Random Convolutional Features and Patch-Based Learning for Multitask Image Classification."
Institute for data-intensive engineering and sciences (IDIES) Annual Research Symposium, Baltimore, MD, October 2023. **1st place winner of best poster award**.

3. "Random Convolutional Features and Patch-Based Learning for Multitask Image Classification."
Johns Hopkins University AI-X Symposium Fall 2023, Charting a New Course, Navigating AI in Research Traditions, Baltimore, MD, September 2023.

4. "Non-pulsatile ODE model of circulation response to hypergravity."
Society for Industrial and Applied Mathematics (SIAM) Conference on Control Theory, Philadelphia, PA, July 2023.

5. "Modeling feedback control response to hemodynamic perturbations in a pulsatile circulation model."
Society for Industrial and Applied Mathematics (SIAM) Conference on Control Theory, Philadelphia, PA, July 2023.

6. "Hemodynamics and oxygen model for the Fontan circulation with feedback control in variable heart rate."
European Community on Computational Methods in Applied Sciences (ECCOMAS), Minisymposium for "Full and Reduced Order Models for Multiphysics and Multiscale Simulations in Cardiovascular Applications", Porto, Portugal, June 2023.

7. "A dynamic mathematical model for the prediction of cardiovascular response to hyper gravity."
American Society of Aerospace Medicine (ASMA), New Orleans, LA, May 2023.

8. "Stroke Risk is Identified by Slow Blood Flow in the Left Atrium"
   Heart Rhythm Society, New Orleans, LA, May 2023.

9. "Modeling the interplay between blood flow and oxygen transport in the defective heart."
   Society for Industrial and Applied Mathematics (SIAM) Dynamics Systems, New Orleans, LA, May 2023.

10. "Hemodynamic Indicators of Stroke Risk Uncovered by Personalized Fluid Dynamics Models."
    Cardiac Physiome Workshop, Irvine, CA, May 2023.

11. "A dynamic model for the control of cardiovascular response to spaceflight."
    International Conference of Aerospace Medicine, Paris, France, Septermber 2022.

12. "Simulation of circulation response to gravitational changes during spaceflight."
    Society for Industrial and Applied Mathematics (SIAM) Life Sciences, Pittsburgh, PA, July 2022.

13. "Optimal fenestration of the Fontan circulation."
    Society for Industrial and Applied Mathematics (SIAM) Annual Meeting, Pittsburgh, PA, July 2022.

14. "Mathematical modeling of cardiac circulation under hypergravity."
    American Society of Aerospace Medicine (ASMA), Reno, NV, May 2022.

15. "Increased intracranial EEG power and duration in temporal lobe seizures with impaired consciousness."
    American Epilepsy Society, Chicago, IL, December 2021.

16. "Mathematical model for an optimally fenestrated Fontan circulation."
    Undergraduate Mathematics Symposium @ University of Illinois, Chicago, Chicago, IL, December 2021.

17. "Mechanisms of impaired consciousness in medial temporal lobe seizures investigated with intracranial EEG."
    Society for Neuroscience (SFN), Chicago, IL, November 2021.

Seminars & Talks

1. "Neural Operators for Learning PDEs on Geometrically Varying Data"
   JHU Applied Mathematics and Statistics Department Seminar, April 2024.

2. "Hemodynamic Indicators of Stroke Risk Uncovered via Personalized Fluid Dynamics Simulations."
   JHU Applied Mathematics and Statistics Department Seminar, September 2023.

3. "Steady-state analysis of gravitational effects on hemodynamics."
   JHU Applied Mathematics and Statistics Department Seminar, February 2023.

4. "Pulsatile model for the Fontan circulation and a feedback control method for heart rate."
   JHU Applied Mathematics and Statistics Department Seminar, November 2022.

5. "Short time-scale dynamics in a computational model of signal propagations in a cerebellar neural network."
   NYU Training Program for Computational Neuroscience Conference, June 2021.

6. "Using mathematics to study and optimize congenital heart disorders."
   NYU College of Arts and Sciences Undergraduate Research Conference, May 2021.

7. "Feedback control of blood pressure and heart rate in a pulsatile cardiovascular model."
   NYU Courant Institute Modeling and Simulation Research Training Group Seminar, March 2021.

8. "Mathematical model for an optimally fenestrated Fontan circulation."
   NYU Courant Institute of Mathematical Sciences Applied Math Research Presentations, October 2020.

Articles

1. "Circulation models assess the impacts of congenital heart defects and hypergravity" *by Jillian Kunze, Society for Industrial and Applied Mathematics (SIAM) News, coverage of Control Theory Conference, August 2023*

2. "Medicine and biology through the lens of mathematics,"*by Zan Ahmad, NYU Medical Dialogue Review, Volume XIV, Issue 2, Page 44-47, April 2020.*

Grants, Awards & Honors

American Heart Association (AHA) Predoctoral Fellowship - $67,388 - (July 2024 - June 2026)
Quantifying Stroke Risk in Atrial Fibrillation with Computational Fluid Dynamics and Machine Learning.

IEEE Engineering in Medicine and Biology AI-X Workshop - Student Fellow - $2000 - (June 2024)
One of 14 students selected from 900 applicants who received a full scholarship to attend summer workshop on AI in Medicine and Healthcare and present research. Chania Crete, Greece.

NIH Cardiovascular Epidemiology Training Grant - T32HL007024 - $27,400 - (July 2023 - June 2024)
Fellowship for PhD students with research focused on cardiovascular disease.

NIH Computational Medicine Training Grant – T32GM119998 - $25,836 - (June 2022 - May 2023)
Fellowship for PhD students working at the Institute of Computational Medicine at JHU.

The Acheson J. Duncan Fund - $3150 - (April 2023)
Acheson J. Duncan Fund for the Advancement of Research in Statistics Travel Award

NIH Computational Neuroscience Training Grant - R90DA043849-03 - $13,336 - (August 2020 - May 2021)
"Short time-scale dynamics in a computational model of signal propagations in a cerebellar neuronal network."
Awarded to six of 50 applicants.

NSF Modeling & Simulation RTG/DMS - 1646339 - $6250 - (May 2020 - August 2020)
Applied Math Summer Undergraduate Research Experience (AM-SURE) at NYU Courant Institute of Mathematical Sciences. Three mathematics undergraduates selected from 60 applicants.

Wilfred L. Ruth S.F. Peltz Research Scholar - $2750 - (May 2020)
Awarded for the strength of NYU DURF proposal for "Optimally fenestrated Fontan circulation."

Dean's Undergraduate Research Fund Grant (DURF) - $1000 - (May 2020)
Project: "Optimal fenestration of Fontan circulation." Research grant awarded by Dr. Joel Ward, NYU College of Arts and Sciences.

Dean's Undergraduate Research Fund Training Grant - $500 - (May 2018)
Project: Self-assembly of A-form 3D DNA crystals of 2'-fluoro DNA. Research grant awarded by Dr. Joel Ward, NYU College of Arts and Sciences.

Teaching

Creator/Instructor	Advanced Topics in Computational Cardiology	Fall 2024	JHU
Creator/Instructor	Mathematical Modeling and Computer Simulation	Fall 2024	JHU
Instructor	Biomedical Engineering Innovation and Design	Fall 2024	JHU
Instructor	Biomedical Engineering Innovation and Design	Summer 2024	JHU
Creator/Instructor	Mathematical Cardiology	Fall 2023	JHU
Instructor	Biomedical Engineering Innovation and Design	Summer 2023	JHU
Teaching Assistant	Channels & Networks in Computational Neuroscience	Spring 2021	NYU
Teaching Assistant	Linear Algebra	Fall 2020	NYU
Teaching Assistant	Calculus I	Spring 2020	NYU
Course Assistant	Thermodynamics	Fall 2019	NYU
Teaching Assistant	Calculus I	Fall 2019	NYU
Course Assistant	Organic Chemistry II	Fall 2019	NYU
Course Assistant	Organic Chemistry I	Spring 2019	NYU

Skills and Proficiencies

Tools: MATLAB, Python, PyTorch, TensorFlow, Java, Linux, LaTeX, Bash, Jupyter Notebook, GitHub
Software: Persyst (EEG analysis software), Spartan (computational chemistry), openCARP (cardiac electrophysiology simulator), Vascular Modeling Toolkit (vmtk), Paraview, life^x finite element solver, ITKSnap, MeshMixer, open3D

Professional Societies

- Society for Industrial and Applied Mathematics (JHU Student Chapter Founder and President)

- American Heart Association (Predoctoral Fellow)

- Heart Rhythm Society (Member)

Service

- Editor-in-Chief for NYU Medical Dialogue Review.

- External Reviewer ICIAM 2023, MICCAI 2024, NeurIps 2024, ICLR 2025.

- East Harlem Tutorial Program (EHTP) Volunteer Physics Tutor (January Tutor of the Month).

- The Perfect Tutor (NYU Non-profit) Volunteer Tutor, Lead Math Tutor.

- Kids Enjoy Exercise Now (KEEN) Volunteer Coach, Brooklyn, NY.

- Meals on Wheels Volunteer.

Relevant Coursework

Graduate Courses:
Johns Hopkins University Applied Mathematics & Statistics: High Dimensional Statistics, Computational Fluid Dynamics, Mathematical Foundations of Computational Anatomy, Convexity in Discrete and Continuous Optimization, Optimal Transport and Manifold Learning, Machine Learning I & II, Matrix Analysis, Real Analysis, Computational Medicine: Cardiology.

NYU Courant Institute of Mathematical Sciences: Advanced Topics in Mathematical Biology: Entropy in Biology, Advanced Topics in Mathematical Physiology: Modeling Neuronal Dynamics, Advanced Topics in Numerical Methods: Immersed Boundary Method for Fluid Structure Interaction, Advanced Topics in Mathematical Physiology: Physiological Control Mechanism

Undergraduate Courses:
NYU College of Arts and Sciences: Numerical Analysis, Modeling and Simulation in Life Sciences, Engineering and Economics, Linear Algebra, Discrete Mathematics, Multivariable Calculus, Honors Analysis I & II, Abstract Algebra, Theory of Probability, Physics Mechanics and Laboratory, Physics E&M and Laboratory, Biochemistry I, Majors Organic Chemistry and Laboratory I & II, Principles of Biology and Laboratory I & II, General Chemistry and Adv. Laboratory I & II, Perception Psychology