Anshul Choudhary

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Profile

I'm a computational scientist working at the intersection of genomics, machine learning and nonlinear dynamics in advancing data-driven scientific discovery. I have an extensive experience in modeling dynamical systems (deterministic and stochastic differential equations) on graphs (complex network topologies) to study the emergence of spaito-temporal patterns in various complex systems spanning from physics to biology.

Education

Indian Institute of Science Education and Research, Mohali, India

Ph.D., Physics — March 2016

- Thesis Topic: *Dynamics on Complex Networks*
- Advisor: Sudeshna Sinha, PhD

Netaji Subhas Institute of Technology, Delhi, India

B.E., Manufacturing Processes and Automation Engineering — May 2009

- Thesis Topic: *Room temperature gas sensor using ZnO- Graphene Nano-composites*

Professional Experience

Associate Computational Scientist — 2022 - Present

The Jackson Laboratory

- Leading research on mathematical models that seeks to employ RNA velocity data derived from single-cell RNA sequencing (scRNA-seq) for the identification of cell state transitions. By incorporating concepts from dynamical systems, particularly the idea of attractor basins, this approach offers a fresh perspective on analyzing scRNA-seq data. Through this integration, the project aims to simulate and predict cell state changes, which in turn facilitates the execution of in-silico perturbation experiments. This project has been funded by NIH's MorPhiC consortium.
- Working on the development of the JAX Animal Behavior System (JABS), an open source platform integrating hardware and software for automated detection and classification of complex animal behavior. This project involved leveraging computer vision, machine learning, and statistical genetics to streamline data acquisition, create precise behavior classifiers, and facilitate collaboration among researchers through classifier sharing and genetic analysis web application.

Postdoctoral Researcher — 2019 - 2022

Nonlinear Artificial Intelligence Lab, North Carolina State University

- Lead the research efforts to apply the ideas from manifold learning for designing neural networks that incorporates symplectic structure to their architecture and therefore can learn any arbitrary conservative system from real-world data without explicit knowledge of the underlying Hamiltonian function even when the phase space is a mixture of order and chaos.
- Discovered the *emergence of neuronal diversity* in artificial neural networks using the gradient based meta-learning algorithm. Such learned diversity provides examples of dynamical systems selecting diversity over uniformity and elucidates the role of diversity in natural and artificial systems.

Postdoctoral Researcher 2016 - 2018

- Theoretical Physics & Complex Systems, University of Oldenburg, Germany
- Worked out the general mechanism behind the emergence of a non-trivial kind of phase synchronization state where weak interactions dominate the dynamics that is generic to wide class of nonlinear oscillator systems.
- Investigated how different traits of species adjusts themselves in a high dimensional trait space in order to avoid competitive exclusion and using ideas from machine learning I was able to identify clustering in this high dimensional space that points to specific relationship between these traits that leads to co-existence and diversity.

Research Fellow 2011 - 2016

- Department of Physical Sciences, IISER Mohali
- Worked on the broad question of how the interplay between the network complexity and dynamical complexity shapes the emergence and stability of the collective dynamics of the system.

Associate Consultant 2009 - 2011

- HCL Axon, Bangalore, India
- Implemented business intelligence SAP modules for client's database.

Research Intern 2009

- National Physical Laboratory, Delhi.
- Designed a room temperature gas sensor for various industrial toxic gases using ZnO-Graphene nano-composites.

Technical Skills

Programming
- Python (PyTorch, NumPy, Pandas, Scikit-Learn, NetworkX, openCV), Julia, C++, SQL, LaTeX.

Machine learning
- Regression (GLM, LMM), classification, dimensionality reduction, clustering, deep neural networks, physics informed machine learning, meta-learning.

OS and environments
- Linux/Unix, HPC, Git, GPU computing.

Journal Publications

Total number of publications: 21 | Citations: 953 | h-index: 11

1. Choudhary, A., Geuther, B. Q., Sproule, T. J., Beane, G., Kohar, V., Trapszo, J., Kumar, V.
   JAX Animal Behavior System (JABS): A genetics informed, end-to-end advanced behavioral phenotyping platform for the laboratory mouse
   eLife, **14**:RP107259 (2025).

2. Adli, Mazhar, et al.
   MorPhiC Consortium: towards functional characterization of all human genes.
   Nature 638.8050 (2025): 351-359.

3. Choudhary, A., Radhakrishnan, A., Lindner, J. F., Sinha, S., & Ditto, W. L.
   Neuronal diversity can improve machine learning for physics and beyond
   Scientific Reports (Nature) 13.1 (2023): 13962.

4. Choudhary, A., Saha, A., Krueger, S., Finke, C., Rosa Jr., E., Freund, J.A., Feudel, U.
Weak-Winner Phase Synchronization: A curious case of weak interactions
Physical Review Research 3(2),023144 (2021).

5. Choudhary, A., Lindner, J. F., Holliday, E. G., Miller, S. T., Sinha, S., Ditto, W. L.
Forecasting Hamiltonian dynamics without canonical coordinates
Nonlinear Dynamics, 1–10 (2021).

6. Miller, S.T, Lindner, J.F., Choudhary, A., Sinha S., Ditto, W.L.,
Negotiating the separatrix with machine learning
Nonlinear Theory and Its Applications, IEICE 12(2) (2021): 134-142.

7. Choudhary, A., Lindner, J. F., Holliday, E., Miller, S. T., Sinha, S., Ditto, W. L.
Physics enhanced neural networks learn order and chaos
Phys.Rev.E, 101(6): 062207, (2020). Highlight: Featured in several media outlets and appeared on Y Combinator!

8. Miller, S.T, Lindner, J.F., Choudhary, A., Sinha S., Ditto, W.L.
The scaling of physics-informed machine learning with data and dimensions
Chaos, solitons fractals: X , 5, 100046 (2020).

9. Chaurasia, S.S., Choudhary, A., Shrimali, M. and Sinha, S.
Suppression and Revival of Oscillations through Time-varying Interaction
Chaos, Solitons and Fractals, 118 (2019)

10. Mitra, C., Kittel, T., Choudhary, A. , Kurths, J., and Donner, R. V.,
Recovery time after localized perturbations in complex dynamical networks
New Journal of Physics, 19(10), 103004 (2017). Highlight: Selected for New Journal of Physics exclusive "Highlights of 2017" collection.

11. Rungta, P.D., Choudhary, A., Meena, C., Sinha, S.
Are network properties consistent indicators of synchronization?
Europhysics Letters(EPL), 117:20003 (2017).

12. Mitra, C., Choudhary, A., Sinha, S., Kurths, J., Donner, R.V.
Multiple-node basin stability in complex dynamical networks
Phys.Rev.E, 95: 032317, 2017.

13. Choudhary, A., Mitra, C., Kohar, V., Sinha, S. and Kurths, J.
Small-world networks exhibit pronounced intermittent synchronization
Chaos (Fast Track), 27(11),111101 (2017).
Highlight: Featured article in Chaos (Issue: November 2017).

14. Choudhary, A., Kohar, V. and Sinha, S.
Preventing catastrophes in spatially extended systems through dynamic switching of random interactions
Pramana, 84:217-228, 2015.

15. Choudhary, A. and Sinha, S.
Balance of interactions determines optimal survival in multi-species communities
PLoS One, 10.1371 (2015).

16. Kohar, V., Ji, P., Choudhary, A., Sinha, S. and Kurths, J.
Synchronization in time-varying networks
Phys.Rev.E, 90:022812, 2014.

17. Choudhary, A., Kohar, V. and Sinha, S.
Noise enhanced activity in a complex network
EPJ-B, 87:1-8, 2014.

18. Choudhary, A., Kohar, V. and Sinha, S.
Taming Explosive Growth through Dynamic Random Links
Scientific Reports (Nature), 4:4308, 2014.

19. Kohar, V., Choudhary, A., Singh, K. P. and Sinha, S.
Verification of scalable ultra-sensitive detection of heterogeneity in an electronic circuit
EPJ-ST, 222:721-728, 2013.

20. Singh, G., Choudhary, A., Haranath, D., Joshi, A. G., Singh, N. and Pasricha, R.
ZnO decorated luminescent graphene as a potential gas sensor at room temperature
Carbon, 50:385-394, 2012.

Preprints

1. Singh, G., Choudhary, A., Sheshadri, T.R.
Excitation of Coherent States: Wave Function Development and Analysis
Arxiv: 1412.0841v1 (2014)

Awards and Fellowship

- NSF early career travel award, USA (2021)
- Best Poster Presentation, Conference on Nonlinear Systems and Dynamics, IISER Mohali (2015)
- School on Hands-on Research in Complex Systems, ICTP, Italy (2014)
- Visiting Research fellow, PIK, Potsdam, Germany (2014)
- CSIR-JRF/SRF (2012), India (not availed)
- Cleared Indian National level exams(GATE, CSIR-UGC-NET, JEST, TIFR) for various fellowships for pursuing graduate studies (2011)

Presentations

Contributory Talks

- SIAM Conference on Applications of Dynamical Systems, (Zoom), USA (2021)
- Manifesting Intelligence, Virtual Zoom Conference, USA (2020)
- 3rd Physics Informed Machine Learning, Santa fe, NM, USA (2020)
- SIAM Conference on Applications of Dynamical Systems, Utah, USA (2017)
- Dynamics Days, CURAJ, Rajasthan, India (2014)
- Inter IISER Physics Meet, IISER Pune, India (2014)
- Conference on Nonlinear Systems and Dynamics, IIT Indore, India (2013)
- Perspectives in Nonlinear Dynamics, Hyderabad, India (2013)
- Institute of Electronics and Telecommunications Engineers, India (2006)

Poster Presentation

- Workshop on Artificial Scientific Discovery 2021, Max Planck Institute for the Science of Light, (Zoom), Germany (2021)
- International Symposium: Recent Advances in Nonlinear Dynamics and Complex Structures, ICBM, Germany (2017)
- Advances in Mathematical and Computational Biology, IIT Ropar (2016)
- Conference on Nonlinear Systems and Dynamics, IISER Mohali (2015)
- Hands-on Research on Complex Systems, ICTP, Trieste, Italy (2014)
- Conference on Condensed Matter and Biological Systems, BHU, Varanasi, India (2013)

Teaching Experience

Instructor, University of Oldenburg — 2017 & 2018
Course **:** Structure and Dynamics of Networks

Teaching Assistant, University of Oldenburg — 2016
Course **:** Computational Modeling using MATLAB