Anshul Choudhary

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🌐 https://anshu957.github.io

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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

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 theory behind the observation of a non-trivial kind of phase synchronization state where weak interactions dominate the dynamics.

🔖 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 emergent 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), C++, SQL, LaTeX.

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

OS and environments
- Linux, Unix (bash), HPC, Git, GPU computing.

JOURNAL PUBLICATIONS

Total number of peer-reviewed publications: 17 | Citations: 614 | h-index: 8

1. 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).

2. 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).

3. 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.

4. 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).

5. 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).

6. 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)

7. 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.

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

9. 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.

10. 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).

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

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

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

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

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

16. 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.

17. 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. Choudhary, A., Radhakrishnan, A., Lindner, J. F., Sinha, S., Ditto, W. L.
   Neural networks embrace learned diversity
   Under review (2022).

2. Choudhary, A. and Feudel, U.
   Clustering in trait space leads to co-existence in a community competing for
   limited resources (2020).

3. Choudhary, A., Ramesh, A., Dutta, P.S., Feudel, U.
   Role of dispersal and nutrient heterogeneity in maintaining supersaturation state
   in a metacommunity (2020).

4. 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)
- Visiting Research fellow, PIK, Potsdam, Germany (2014)

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)

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

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