Anshul Choudhary

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I'm an engineer turned physicist currently working at the intersection of Network Science, Nonlinear Dynamical Systems and Machine Learning.

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*

Work Experience

Postdoctoral Researcher — 2019 - Present

- Applied ideas from manifold learning to design 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.
- Studied the effect of external noise on the dynamics of stochastic gradient descent and the geometric nature of minima it converges to using discrete fokker-planck equation.
- Nonlinear Artificial Intelligence Lab, NCSU

Postdoctoral Researcher — 2016 - 2018

- 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.
- Theoretical Physics & Complex Systems, University of Oldenburg

Research Fellow — 2011 - 2016

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

Associate Consultant — 2009 - 2011

- Implemented various business intelligence SAP modules for client databases.
- HCL Axon

Research Intern — 2009

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

Skills

Programming

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

OS and environments

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

Journal Publications

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

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

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

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

- 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)

Awards and Fellowship

- NSF early career travel award, SIAM DS21 Conference, USA (2021)
- Best Poster Presentation, Conference on Nonlinear Systems and Dynamics, IISER Mohali (2015)
- Visiting Research fellow, PIK, Potsdam, Germany (2014)
- CSIR-JRF/SRF (2012), (not availed)

Workshop Attended

- Winter School on Quantitative Systems Biology: Learning and Artificial Intelligence, ICTP, Italy (2018)
- Hands-on Research in Complex Systems, ICTP, Italy (2014)
- RRI School on Statistical Physics, Bangalore, India (2013)
- DST SERC School on Nonlinear Dynamics, IISER Pune, India (2011)

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

Teaching Assistant, IISER Mohali — 2012 & 2013
Courses : Modern Physics Lab, Classical Mechanics I