Moshir Harsh, Ph.D.

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EDUCATION

PhD in Statistical Physics of Biological and Complex Systems 2024
Georg-August-Universität Göttingen, *Germany*
- Grade "*magna cum laude*"
- Cohort of **International Max Planck Research School** (IMPRS-PBCS) Göttingen
- Thesis "Dynamics and Machine Learning Inference using Memory in Stochastic Biochemical Reaction Networks"

MSc in Fundamental Physics 2019
École Normale Supérieure (ENS), *Paris, France*
- Grade "*trés bien*" (very good); Highly rigorous master's degree at France's top school

BSc (Research) Physics and Biology 2017
Indian Institute of Science (IISc), *Bengaluru, India*
- Grade "*distinction*"
- Interdisciplinary program with mandatory courses in humanities, engineering and natural sciences at India's top university (according to Times Higher Education university rankings 2024)

EXPERIENCE

Max Planck Institute for Molecular Physiology, Dortmund and **Institute for Artificial Intelligence in Medicine, Essen** *Dortmund, Germany*
Wissenschaftlicher Mitarbeiter (Postdoctoral research associate) Oct 2024 - present
- Leading an interdisciplinary research project on methods for next generation epigenetic sequencing.
- Developing statistical algorithms, bioinformatics methods and machine learning solutions for *de novo* sequencing of epigenetic RNA/DNA modifications and for classifying them as clinical disease biomarkers.
- Implementing reproducible automatic end-to-end workflow pipelines from data acquisition from tandem mass spectrometry to sequence reconstruction.

Institut für Theoretische Physik, Georg-August-Universität Göttingen *Göttingen, Germany*
Wissenschaftlicher Mitarbeiter (Doctoral research associate) Jan 2020 - June 2024
- Undertook the responsibility for the PhD research project which included identifying relevant questions, developing and testing models, assessing solutions, preparing scientific publications and communicating the results via oral and poster presentations at multiple international conferences.
- Developed a novel physics-inspired machine learning algorithm for robust Bayesian network reconstruction and inference from non-stationary time-series. Demonstrated its applicability on time-series data from *EGFR*, a biological growth-regulation protein interaction network.
- Developed path-integral based approximation and likelihood inference methods for biochemical reaction networks dynamics with large intrinsic-noise fluctuations using tools from statistical field theory.
- Programmed a *Julia* software package *'ACheDMy'* implementing this theory (to be soon published), demonstrating state-of-the-art performance for gene regulation dynamics and enzyme kinetics.
- Managed a small team of a master's and a bachelor's students supervising their respective theses research, overseeing their development, planning, feedback incorporation, and publication preparation.
- Tutored 3 bachelor-level physics courses for ~20 students, namely Computational Methods of Physics (in C), Classical Field Theory & Quantum Mechanics; received outstanding teaching reviews for each.

Laboratoire de Physique Théorique, École Normale Supérieure (ENS) *Paris, France*
Master's Year 1 Stagiaire (Research Intern) Feb 2018 - Aug 2018

- Demonstrated the emergence of localised receptive fields in the weight space in *restricted Boltzmann machines (RBMs)*, a popular *generative AI* algorithm, as a general consequence of representations of invariant distributions of inputs, akin to *place-cells* cells in mammalian brains.
- Reported a *retarded learning* phase transition, elucidating the quality and quantity of data needed for RBMs to 'learn' the training data-set.

European Molecular Biology Laboratory (EMBL) *Heidelberg, Germany*
Bachelor's Thesis (Research Trainee) July 2016 - Jan 2017

- Extracted quantitative insights from the statistical analysis of high-throughput live super-resolution microscopy images of the *Nuclear Pore Complex (NPC)* showing two different in-vivo assembly mechanisms.
- Assisted in microscope development, image-analysis & ML pipelines for quantitative data extraction.
- Cherished working together in the multinational and multidisciplinary team of biologists, physicists and computer scientists.

SCHOLARSHIPS AND AWARDS

2021 - 2024	Max Planck (IMPRS-PBCS) *Excellence Fellowship* for doctoral research
2017 - 2019	*ICFP-Labex* scholarship for Masters, Paris Science & Letters (PSL)
2016 - 2017	*WISE* scholarship, Deutscher Akademischer Austauschdienst (DAAD)
2012 - 2017	Kishore Vaigyanik Protsahan Yojana (*KVPY*) fellowship, Govt. of India

LANGUAGES

- English - bilingual proficiency
- German – B2
- Hindi - native

IT SKILLS

- **Programming languages**: Python, Julia, C, MATLAB
- **Software and Services**: Git, SQL, LaTeX, Excel, Linux

HOBBIES

- Salsa dancing enthusiast
- Quizzing and trivia
- Certified advanced scuba diver

SELECTED PUBLICATIONS

- Harsh, M.; Tubiana, J.; Cocco, S.; Monasson, R. `Place-Cell' Emergence and Learning of Invariant Data with Restricted Boltzmann Machines: Breaking and Dynamical Restoration of Continuous Symmetries in the Weight Space. J. Phys. A: Math. Theor. 2020. https://doi.org/10.1088/1751-8121/ab7d00.
- Harsh, M.; Sollich, P. Accurate Dynamics from Self-Consistent Memory in Stochastic Chemical Reactions with Small Copy Numbers. J. Phys. A: Math. Theor. 2023. https://doi.org/10.1088/1751-8121/acfd6a.
- Harsh, M.; Vulpius, L. G.; Sollich, P. Physics-Inspired Machine Learning Detects 'Unknown Unknowns' in Networks: Discovering Network Boundaries from Observable Dynamics. Mach. Learn.: Sci. Technol. 2024, 5 (4), 045046. https://doi.org/10.1088/2632-2153/ad9194.
- Harsh, M.; Sollich, P. Dynamical variational approach for stochastic discrete population dynamics with applications to chemical reaction networks, *in preparation.*
- Harsh, M.; Sollich, P. Adaptive Chemical Dynamics from Memory, *in preparation.*

SELECTED TALKS

- Speaker at International StatPhys28 Conference, Tokyo 2023.
- Speaker at Deutsche Physikalische Gesellschaft (DPG) Meetings - Berlin 2024, Regensburg 2022, Virtual 2021.
- Speaker at Les Houches workshop on Statistical Physics and Machine Learning 2020.
- Participant at Dresden Summer School in Systems Biology, 2018.