

Shabnam Sahay

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EDUCATION

Indian Institute of Technology Bombay



2019-23

Bachelor of Technology (Honors) in Computer Science and Engineering | CGPA: 9.22/10

Minor in Biosciences and Bioengineering | CGPA: 9.80/10

Thesis: *Probabilistic Edge Tuning of Boolean Networks to Influence Cell Fate Distributions*

PUBLICATIONS/PRESENTATIONS

- **Sahay S**, Adhikari S, Hormoz S, Chakrabarti S. *An improved rhythmicity analysis method using Gaussian Processes detects cell-density dependent circadian oscillations in stem cells*. In: *Bioinformatics*, Volume 39, Issue 10, October 2023. doi: 10.1093/bioinformatics/btad602.
- **Sahay S**, Adhikari S, Hormoz S, Chakrabarti S. *Detecting circadian oscillations in lineage trajectories with Gaussian Processes*. Poster presented at: Simons Symposium - Cellular Lineages & Development, Alleppey, Kerala, India; Nov 1-4 2022. 
- **Sahay S**, Wong BS, Li R. *Effects of chronic hypo-osmotic stress on the growth and cell cycle of Nalm6 cells*. Poster presented at: MUST Programme Poster Session, Mechanobiology Institute, National University of Singapore, Singapore; Jul 29 2022. 

SCHOLARSHIPS

- Awarded the MUST Programme Fellowship by the National University of Singapore 2022
- Received the Engineering Vacation Research Scholarship from the University of Sydney 2022
- Offered the MtL-URO Fellowship by the Max Planck Institute for Medical Research 2021
- Awarded the prestigious Aditya Birla Scholarship (**top 16** engineering students across India) 2019
- Received the Desai-Sethi Family Scholarship (**1st**-ranked female across India in JEE Advanced) 2019

RESEARCH EXPERIENCE

Probabilistic Edge Tuning of Boolean Networks to Influence Cell Fate

Ongoing

Guide: Prof. Ganesh Viswanathan, Biomolecular Engineering Lab, IIT Bombay

- Modelling stochastic cancer signalling networks in a boolean framework with random asynchronous updates
- Manipulating steady state properties (corresponding to distribution of cell fates) via probabilistic edge tuning
- Verifying experimental edge-tuning outcomes and identifying biological entities key to influencing phenotype

Agent-Based Modelling of Cellular Proliferation and Movement Dynamics

2023

Guide: Prof. Sandip Kar, Theoretical Systems Biology Lab, IIT Bombay

- Modelled heterogeneous single cells as hexagonal lattice agents having contact-based migration propensities
- Analysed corresponding experimental time-lapse microscopy data to extract information for model validation
- Performed statistical analyses to correlate cell cycle phase with cell velocity under varying culture conditions

Estimating the Dynamics of Large Boolean Networks

2022

Guide: Prof. Ganesh Viswanathan, Biomolecular Engineering Lab, IIT Bombay

- Constructed partial state-transition graphs with minimal permutations recapitulating true network dynamics
- Derived minimal state spaces capable of reproducing true network flow and attractor absorption probabilities
- Utilised influence maximisation to identify minimal node sets driving the network towards specified attractors
- Evaluated derived approximations and mean-field estimates of network dynamics with suitable error metrics

Effects of Chronic Hypo-Osmotic Stress (CHS) on Suspension Cells

2022

MUST Programme | Guides: Dr. Bin Shen Wong & Prof. Rong Li, Mechanobiology Institute, NUS

- Compared the effects of CHS on cell cycle and growth in suspension (Nalm6) cells and adherent (RPE) cells
- Characterised variations in population growth and viability through cell counting and time-lapse microscopy
- Performed western blotting independently with positive controls to quantify upregulation in p53 expression
- Identified significant increase in cell cycle arrest of RPE cells relative to Nalm6 cells under CHS via FACS

Detecting Oscillations in Biological Data with Gaussian Processes

2021–22

Guide: Prof. Shaon Chakrabarti, Simons Centre, National Centre for Biological Sciences

- Developed an R package combining GP regression with Bayesian model selection to detect noisy oscillations
- Identified and adapted gaussian process kernels best-suited for capturing non-stationary oscillatory patterns
- Evaluated performance against existing methods on exhaustive simulated datasets through ROC curves

Evolutionary Dynamics of the Novel Coronavirus

2021

Summer Undergraduate Research Program | Guide: Prof. Supreet Saini, IIT Bombay

- Constructed a pipeline in Perl to retrieve, process and analyze genomes of 400,000+ SARS-CoV-2 sequences
- Utilised codon usage bias to visualize translation profiles & temporal variation of dN/dS for each gene
- Implemented the Needleman-Wunsch algorithm to extract and analyze information of indel mutations
- Traced mutation lineages in the S gene and generated ancestral trees for identification of epistatic linkages

INTERNSHIPS

Dissipative Particle Dynamics in Jax-MD

2023

PI: Dr. Anton Goloborodko, Institute of Molecular Biotechnology, Vienna Biocenter

- Implemented and integrated DPD into the existing public codebase with optimised Jax-vectorised operations
- Incorporated the novel ABOBA integration scheme and validated thermodynamic accuracy across systems

Multiphysics Modelling of DNA Nanorobots

2022

Engineering Internship Program | PI: Prof. Marcela Bilek, University of Sydney

- Built, tested, and refined a deformable mesh model in C++ to simulate the rolling-adhesion of leukocytes
- Utilised a variable mesh to enable design of DNA origami nanorobots that can act as synthetic leukocytes

Coarse-Grained Model for Protein-Protein Docking

2021

Max Planck MTL-URO Program | Guide: Prof. Martin Zacharias, Technical University of Munich

- Implemented a reduced amino acid representation for faster protein docking and refined selection of minima
- Optimised LJ potential parameters and pseudo-atom radii via energy minimization on benchmark complexes
- Refined attraction-repulsion parameters by performing comparison of native complexes with artificial decoys

PROFESSIONAL EXPERIENCE

Software Engineer | Azure Networking Team, Microsoft IDC India

Present

- Working on real-time buildout and management operations of regional network infrastructure under Azure

Software Engineer Intern | Azure Networking Team, Microsoft IDC India

2022

- Built a predictive maintenance model for link flaps, integrating device metrics and link configuration data
- Designed custom features to enable forecasting and evaluated multiple classifiers for maximal f1-scores
- Deployed the optimised model as a web-service for real-time flap prediction, achieving $\geq 70\%$ accuracy
- Received an offer to join the team full-time after graduation based on exemplary internship performance

TEACHING AND MENTORING EXPERIENCE

Undergraduate Teaching Assistant | IIT Bombay

2021-23

- Mathematical Foundations of AI & ML (NCM-CEP) | Spring 2023 | Instructor: Prof. S. Kalyanakrishnan
- Computer Systems Bootcamp | Summer 2022 | Instructors: Prof. Mythili Vutukuru and Prof. Puru Kulkarni
- PH 107 - Quantum Physics and its Applications | Autumn 2021 | Instructor: Prof. Shankaranarayanan S.
- BB 101 - Biology | Spring 2021 | Instructors: Prof. Ambarish Kunwar and Prof. Neeta Kanekar

Designed and verified coding assignments, conducted tutorials and help sessions, and graded examinations

Department Academic Mentor | Student Mentorship Program, IIT Bombay

2021-22

- Selected out of 70+ applicants through a rigorous procedure based on interviews and strong peer reviews
- Aided 7 sophomores with curriculum-planning and balancing their academic and extracurricular endeavours

Computational Biology Mentor | Summer of Science, Institute Technical Council, IIT Bombay

2023

- Guided 2 sophomores new to computational biology by structuring a learning plan and curating resources
- Selected relevant journal articles to introduce current research in the field pertinent to their specific interests

ACADEMIC ACHIEVEMENTS

- Achieved **All India Rank 10** among over 240,000 aspirants in the JEE Advanced 2019
- Attained the **Highest Mark in India** in A-Level Physics in March-June Cambridge Examinations 2019
- Secured **3rd Place in India** for Best Across 3 A-Levels in March-June Cambridge Examinations 2019
- Achieved 99.97 percentile in the JEE Main among over 1 million aspirants 2019
- Scored 120/120 in TOEFL iBT, and 170/170 (Quantitative) + 164/170 (Verbal) in GRE General 2022
- Awarded the AP grade for exceptional performance (**top 8** out of 295) in Environmental Studies 2022
- Secured a perfect **10/10** Semester Performance Index in the final two semesters of B.Tech 2023

SELECTED ACADEMIC PROJECTS

Generating 3D Chromatin Configurations | Guide: Prof. Ranjith Padinhateeri, IIT Bombay 2022

- Constructed 3D SBS polymer ensembles modelling chromatin loci corresponding to experimental Hi-C input
- Implemented Simulated Annealing Monte Carlo optimization to identify the model best describing the input
- Analysed temporal variation of simulated polymer descriptors including radius of gyration to evaluate accuracy

Simulating Sympatric Speciation | Guide: Prof. Supreet Saini, IIT Bombay 2021

- Modelled beak-size variation over time of a bird population having bimodal beak-size vs. fitness distribution
- Incorporated trade-off between attracting mates and maximising survival in males, and choosiness in females

Orientation Selectivity of Visual Neurons | Online Quantitative Biology Workshop Project 2020

- Extracted fluorescence traces from image stacks of visual neurons responding to a rotating light grating
- Constructed individual orientation tuning curves with a baseline fluorescence to demarcate ON/OFF periods
- Evaluated orientation selectivity indices and visualized the location-OSI relationship with a population map

TECHNICAL SKILLS

Programming: C++, C, Python, Perl, Java, R, Bash, Awk, Numpy, Scipy, Matplotlib, SQL, Pandas

Software: L^AT_EX, Git, MATLAB, PyMOL, BLAST, LAMMPS, ImageJ, Doxygen, Beamer

KEY COURSEWORK

Computer Science: Data Structures, Design & Analysis of Algorithms, Geometric Algorithms, Logic for Computer Science, Automata Theory, Implementation of Programming Languages, Data Analysis & Interpretation

Biology: Cell and Molecular Biology, Metabolism and Bioenergetics, Immunology, Biochemistry, Molecular Biophysics, Topics in Evolution, Bioinformatics, Quantitative Biology Workshop (MITx on edX)

LEADERSHIP EXPERIENCE

Senior Convener | Roots, Classical and Folk Arts Club, IIT Bombay 2021-22

Conducted workshops for all experience levels and coordinated both student-led and professional performances

Editor | Bitstream, CSE Department Newsletter, IIT Bombay 2021-22

Wrote, edited and curated articles capturing student and faculty perspectives on department-specific issues

Web Convener | Insight, Official Student Media Body, IIT Bombay 2020-21

Developed multiple audience-specific micro-sites to increase the online presence of Insight during the pandemic

Cultural Secretary | Hostel Council, Hostel 15, IIT Bombay 2019-20

Contributed to the organisation and execution of large-scale festival celebrations to strengthen hostel culture

EXTRACURRICULAR ACTIVITIES

- Trained for 9 years and completed **Arangetram** (graduation) in the classical dance Bharatanatyam 2015
- Awarded **1st Position** in Solo Classical and Folk Dance competition held for all freshmen at IITB 2019
- Choreographed & performed classical dance in IITB's Annual Dance Show for a 2000+ audience 2023
- Member of the IITB contingent securing **1st Position** in Scrabble at the **Inter-IIT** Cultural Meet 2023
- Represented IITB at the inaugural internationally rated and WESPA certified IITB Scrabble Open 2022
- Secured 2nd runner-up position in the IITB Institute Scrabble League among 80+ participants 2021
- Attended the Theoretical Computer Science Winter School at IIT Delhi (one of 40 selected attendees) 2022
- Achieved **distinction** in Trinity Piano Grade 1, and completed a year-long violin course at IITB 2019