# 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*

## 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, 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-osmotc 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** *Ongoing*
*Guide: Prof. Sandip Kar, Theoretical Systems Biology Lab, IIT Bombay*
- Modelling heterogeneous single cells as hexagonal lattice agents having contact-based migration propensities
- Analysing corresponding experimental time-lapse microscopy data to extract information for model validation
- Performing 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, Biomolceular 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 experimental data and exhaustive simulated datasets

**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*
- 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

**Anti Tic-Tac-Toe** | *CS747: Fundamentals of Intelligent and Learning Agents* *2021*

- Encoded Tic-Tac-Toe with reversed winning conditions into a Markov Decision Process for each player
- Derived a player's optimal MDP policy utilising Howard's Policy Iteration, given a fixed opponent policy

**Mastermind Player** | *CS228: Logic for Computer Science* *2021*

- Encoded the moves of the Mastermind game into a SAT problem solved with conflict-driven clause learning
- Developed the 'codebreaker' player in z3py, making it robust to the codemaker lying upto 50% of the time

## TECHNICAL SKILLS

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

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

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

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

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

## EXTRACURRICULAR ACTIVITIES

- Awarded **1st Position** in Solo Classical and Folk Dance competition held for all freshmen at IITB *2019*
- Trained for 9 years and completed **Arangetram** (graduation) in the classical dance Bharatanatyam *2015*
- 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 IITB Scrabble Open (internationally rated and WESPA certified) *2022*
- Achieved **distinction** in Trinity Piano Grade 1, and completed a year-long violin course at IITB *2019*