Shabnam Sahay

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Senior Undergraduate, IIT Bombay

Education

Indian Institute of Technology Bombay ***2019 – 2023 (expected)***

- Bachelor of Technology in Computer Science and Engineering with Honors
- Minor in Biosciences and Bioengineering

Ahmedabad International School ***2017–2019***

- Cambridge International A Levels: Physics, Chemistry, Maths, Biology *4 A*s (94.20%)*

Research Interests

Computational & Systems Biology, Molecular Biology, Genetics, Evolutionary Biology, Biophysics

Research Experience & Internships

Cellular Response to Chronic Hypo-Osmotic Stress *Ongoing*
Guide: Professor Rong Li and Dr. Bin Shen Wong | MUST Programme *National University of Singapore*

Predictive Model for Optical Failures *Ongoing*
Hyperscale Networking Team | Software Engineering Internship *Microsoft IDC India*

Multiphysics Modelling of DNA Nanorobots *2022*
Guides: Professor Marcela Bilek & Dr. Mark Baldry | Engineering Research Internship Program *University of Sydney*

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

Detection of Circadian Rhythms in qPCR Data *2021-22*
Guide: Professor Shaon Chakrabarti | Research Project *National Centre for Biological Sciences*

- Developed an R package to identify oscillatory qPCR data with incorporation of replicate errors and missing observations
- Determined and fine-tuned gaussian process kernels best-suited for non-stationary biological data through model selection
- Evaluated performance against existing rhythmicity detection methods through ROC curve construction for varied datasets

Coarse-Grained Model for Protein-Protein Docking *2021*
Guide: Professor Martin Zacharias | Max Planck Matter to Life URO Program *Technical University of Munich*

- Built a reduced amino acid representation for faster protein-protein docking computation and refined selection of minima
- Optimised LJ potentials and pseudo-atom interaction radii through energy minimization on benchmark protein complexes
- Refined attraction-repulsion parameters through evaluation of performance of native complexes against artificial decoys

Evolutionary Dynamics of the Novel Coronavirus *2021*
Guide: Professor Supreet Saini | Summer Undergraduate Research Program *IIT Bombay*

- Constructed a pipeline in Perl to extract, process and analyze SNPs in 400,000+ available SARS-CoV-2 genome sequences
- Utilised codon usage bias values to build translation profiles for each gene, and visualized variation of dN/dS over time
- Implemented the Needleman-Wunsch algorithm to extract information about indel mutations present in the sequences
- Extracted lineages of mutations in the spike protein and generated ancestral trees to identify possible epistatic linkages

Academic Achievements

- Achieved **All India Rank 10** among over 240,000 aspirants in the JEE Advanced conducted by the IITs *2019*
- Attained the **Highest Mark in India** in A-Level Physics in the March-June Cambridge Examination series *2019*
- Secured **3rd Place in India** for Best Across 3 A-Levels in the March-June Cambridge Examination series *2019*
- Achieved 99.97 percentile in the Joint Entrance Examination (Main) among over 1 million aspirants *2019*
- Selected for the KVPY Fellowship by IISc Bangalore and DST, Govt. of India with All India Rank 256 *2018*

Honors and Awards

- Awarded the MBI Undergraduate Summer Training Fellowship by the National University of Singapore *2022*
- Received the Faculty of Engineering's Vacation Research Internship Scholarship from the University of Sydney *2022*
- Awarded the prestigious Aditya Birla Scholarship, **one among 16** such engineering students across India *2019*
- Received the Desai-Sethi Family Scholarship for securing the **highest rank** among females in JEE Advanced *2019*

Selected Academic Projects

Compiler for a C-Like Language, *CS316: Implementation of Programming Languages Lab* *2022*
- Built a compiler for a C-like language, including generation of Intermediate Representations such as Three Address Code
- Integrated support for arithmetic and relational expressions, control flow statements, and function definitions and calls
- Implemented the scanner in lex, parser in yacc and created a modular system in C++ to build the Abstract Syntax Tree

Anti Tic-Tac-Toe, *CS747: Fundamentals of Intelligent and Learning Agents* *2021*
- Encoded the game of Tic-Tac-Toe with the winning conditions reversed into a Markov Decision Process for each player
- Utilised Howard's Policy Iteration to derive the optimal MDP policy for a player given a fixed MDP policy for the opponent

Custom Linux Shell in Xv6, *CS333: Operating Systems Lab* *2021*
- Built a shell in C to run all Unix terminal commands by forking child processes and invoking the respective executables
- Integrated support for simultaneous execution of multiple processes serially or parallelly in the foreground or background
- Created custom signal handling routines to enable controlled termination of foreground processes or the complete shell

Simulating Sympatric Speciation, *supervised project under Professor Supreet Saini* *2021*
- Modelled the variation over time of beak size of a bird population having a bimodal distribution of beak-size vs. fitness
- Incorporated the trade-off between attracting partners and optimising survival chances to recreate disruptive selection

Mastermind Player, *CS228: Logic for Computer Science* *2021*
- Encoded the moves of the logic-based mastermind game into a SAT problem solved with conflict-driven clause learning
- Developed the 'codebreaker' player logic in the z3py library which is robust to the codemaker lying $\leq 50\%$ of the time

Manipulating Morphisms, *CS213: Data Structures & Algorithms* *2020*
- Designed an algorithm to find the length of the infinite word of any prolongable homomorphism, as well as its ith character
- Extended the KMP algorithm to efficiently locate specified substrings and positions of subsequences in the infinite word

Teaching and Mentoring

Teaching Assistant, *Computer Systems Bootcamp | Instructor: Prof. Mythili Vutukuru* *2022*
- Designed and verified problem statements and solutions, and conducted live help sessions to aid with self-paced learning

Teaching Assistant, *PH 107 - Quantum Physics | Instructor: Prof. Shankaranarayanan S.* *2022*
- Conducted weekly tutorials and biweekly general doubt-clearing sessions for first-year students, and graded examinations

Teaching Assistant, *BB 101 - Biology | Instructor: Prof. Ambarish Kunwar* *2021*
- Conducted weekly tutorial sessions for 80 first-year students on physical biology & biomedical engineering course modules

Department Academic Mentor, *Dept. of Computer Science & Engineering* *2021-22*
- Selected through interview and extensive peer reviews to support 7 sophomores in a facilitative and developmental role
- Eased their transition into academics of the department-specific curriculum and provided guidance with course planning

Relevant Coursework

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

Biology: Cell and Molecular Biology, Metabolism and Bioenergetics, Biochemistry, Immunology, Molecular Biophysics, Quantitative Biology Workshop (MITx, edX), Bioinformatics I (UCSD, Coursera)

Technical Skills

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

Software: LaTeX, Git, MATLAB, Doxygen, Beamer, Android Studio, PyMOL, OpenFOAM

Co-curricular Responsibilities

- **Senior Convener**, Roots, Classical and Folk Arts Club
- **Web Convener**, Insight, Official Student Media Body
- **Editor**, BitStream, CSE Dept. Newsletter *2021-22*
- **Cultural Secretary**, Hostel 15 *2020-21, 2019-20*

Extracurricular Activities

- Awarded **1st Position** in the Solo Classical and Folk Dance competition held for all freshmen at IIT Bombay *2019*
- Trained for 10 years and completed ***Arangetram*** (graduation) in the Indian classical dance Bharatanatyam *2015*
- Secured overall runner-up position in the Inter-IIT Scrabble League, and 3rd place in IITB's Institute League *2021*