

ARHAN VORA

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EDUCATION

Indian Institute of Science Education and Research Mohali

2020 – 2025

BS-MS in Physics - CPI - 7.75/10

Mohali, India

Ahmedabad University

2019 – 2020

Bachelor Of Technology, left partway through sophomore year - CGPA 3.42

Ahmedabad, India

INTERESTS

Mathematical Modelling and Computational Thinking, Evolutionary Theory, Agent Based Simulations

TECHNICAL SKILLS

Programming Languages: Julia, Python, Wolfram, C, R

Developer Tools: Agents.jl, DynamicalSystems.jl, DrWatson (a scientific project and simulation management tool), Mathematica (for analytic work), numpy, scipy, matplotlib, pandas

PROJECTS AND EXPERIENCE

Information Transfer in Moving Animal Groups | TEE Lab At IISc Bangalore

June 2022

- This was a group summer project with Professor Vishwesha Guttal intended to introduce us to Collective Behaviour.
- The first step was to work together to implement an agent based flocking model from Couzin et al 2002. This was done using Agents.jl
- Once the basic model was in place, we read David J Sumpter's "Principles of Collective Behaviour" and tried to see the ideas reflected in the model.
- Finally, we read the 2014 paper "Initiation and Spread of Escape Waves", attempting to understand how information (of presence of predators or of food) moves through animal groups through simulations and computational experiments.

Probabilistic Flocking Models for Mixed Species Groups ↗ | KS Lab at IISc Bangalore

June 2022

- This summer project with Professor Kartik Shanker investigated the different mixed species flocking behaviours of birds and fish, and their ecological origins.
- Modifying the Couzin et al model from the information transfer project with a Bernoulli random variable (click title for details), we implemented a flocking model that we could tweak the parameters of to display and not display self sorting, the main differentiator between fish and bird flocks.
- After having implemented the base model, we began a collaboration with Professor Deepak Subramani (CDS, IISc) looking to replicate patterns seen in experiments by Kartik's lab, in our model (this project is still ongoing).

Bacterial Growth under Ampicillin Stress | Evolution and Demography Team at ISEM

May 2023

- In this project with Professor Guillaume Martin we set out create a quantitative model of the population dynamics of E. Coli given a certain concentration of ampicillin being introduced into the environment. This model is meant to dovetail with experiments Guillaume has been doing in his lab.
- To model bacterial death, we must first model the action of ampicillin on E. Coli, we looked through the literature to understand the binding of ampicillin on receptors present on the bacterial cell wall. Once this was done, we used fast-slow approximations (exploiting a separation in timescales) to get an expression for the density of imperfections in the cell wall. Using Poisson Processes, we connected the density of imperfections to a probability of death for E. Coli.
- This probability of death was now connected to an epidemic style model for our bacterial population to complete our model. Since the equations are all linear, we were able to obtain analytic expressions for Live, Sick and Dead Bacterial densities in our population, even replicating classic CFU count experiments done in E. Coli.
- This project is currently in process of being written up for publication (with some more analytic work to be added soon).

Understanding Our Ecosystems through a Plague | The Santa Fe Institute

December 2023

- This is a project that emerged out of the Complexity Global School, where we will be guided by Dr. Brandon Ogbunu and Dr. Travis Holmes, with the intention of exploiting the natural experiment that was COVID-19, to better understand our ecosystem management apparatus.

- We hope to create a framework for researchers across the world to study the effects of COVID-19 (and the bundle of different perturbations like changes in human behavior, economic shifts, and government policies, that comes with it) on their biodiversity and conservation systems.
- We plan to pick one source, create a pipeline to analyze it, and see if we can design components from the pipeline to create a framework that can be used beyond just our own project.

Mathematical Models for Evolutionary Rescue | [Max Planck Institute for Evolution](#)

June 2023

- The goal of this symposium was to bring together theoreticians working on a wide range of rescue models — from 1-locus to infinite-loci, from conservation to medicine — to synthesize what we already know and to identify key knowledge gaps.
- In addition to invited and contributed talks and posters there were “pitched discussions” on specific topics, designed to motivate and direct the future of evolutionary rescue theory.

Complexity Global School | [The Santa Fe Institute](#)

December 2023

- The Complexity Global School for Emerging Political Economies at IIT Bombay is an intensive, 12-day program that provides deep exposure to the latest complex systems methods, models, and frameworks for thinking about economics and governance.
- This program will feature a series of lectures that introduce network analysis, computational social science (including agent-based models, but also things like NK landscapes, etc.), applied scaling theory, emergent engineering, and digital humanities with applications to problems like inequality, climate change, belief dynamics, democracy and the future of work

Archiving The Times | [Ahmedabad University](#)

January 2021

- A special project course run at Ahmedabad University when the pandemic hit, where we worked with researchers to document the effects of the COVID-19 pandemic to our Neighbourhoods, Climate and Businesses around us.
- The 2002 riots led the Muslim population to migrate to the older, less prosperous parts of Ahmedabad (hence resulting in segregation of the city on religious lines). In the initial surge of the pandemic, the case load in these parts of the city was disproportionately high, leading to a demonisation of the muslim population in the public rhetoric. This project sought to explain the higher caseload as a result of disproportionately high population density and lack of sanitation in the older parts of the city, rather than irresponsibility of the muslim population.
- Ultimately due to the political nature of our studies, they couldn't be fleshed out and presented.

RELEVANT COURSEWORK AND GRADES

Math courses : Non-Linear Dynamics, Probability and Statistics, Linear Algebra, Multivariable Calculus, Real Analysis, Differential Geometry in 3 Dimensions, Ordinary Differential Equations, Machine Learning, Number Theory and Cryptography.

Liberal Arts Courses : Archiving The Times, Democracy and Justice, Neighbourhoods, Understanding Culture, Water, Advanced Writing, Curriculum Design, Introduction to Literature, Cities, World Cinema**, Charlie Chaplin's Aesthetic Universe

Biology courses : Advanced Evolutionary Theory**, Genetics and Evolution, Behaviour and Ecology, Cellular basis of life, Gene expression and Development (each course was accompanied by a corresponding lab course)

Physics courses : Physics of Fluids**, Solid State Physics, Nuclear and Particle Physics, Statistical mechanics, Advanced Quantum Mechanics, Classical Mechanics, Quantum Mechanics, Electrodynamics, Waves and Optics, Thermodynamics

** courses in the current semester

EXTRACURRICULAR ACTIVITIES

- Convener of Film Club of IISER Mohali
- Teaching Associate for Genetics and Evolution, a course offered to a class of 250 students from Math, Biology, Chemistry and Physics
- Member of the IISER Mohali Tennis Team
- Representing IISER Mohali at the Inter IISER Cultural Meet, at the Short Story Writing Competition
- Story Writer for the The Literary and Debate Society's Murder Mystery
- Sports Writer, with articles for Sportstar(a popular Indian sports magazine) and Manthan, IISER Mohali's student magazine
- An active member of the Literary and Debate Society, Quizzing Circle, Biology Discussion Forum, Physics Club, Turing (Programming) Club and Gaming Club of IISER Mohali.