**Ashwin Goyal**
**Computer Science & Engineering**
**Indian Institute of Technology Bombay**

**210050024**
**B.Tech.**
**Gender: Male**
**DOB: 30/08/2003**

| Examination | University | Institute | Year | CPI / % |
|---|---|---|---|---|
| Graduation | IIT Bombay | IIT Bombay | 2025 | |
| Intermediate | CBSE | Delhi Public School, Navi Mumbai | 2021 | 99.20% |
| Matriculation | CBSE | Delhi Public School, Navi Mumbai | 2019 | 97.60% |

Pursuing a **Minor** in Physics

## Scholastic Achievements

- **Department Rank of 8** among **190+** students in the **Computer Science and Engineering Department** *(2023)*
- Secured **All India Rank 34** in **Joint Entrance Examination (Advanced)** among 1,41,000+ shortlisted students *(2021)*
- Awarded the prestigious **Kishore Vaigyanik Protsahan Yojana Scholarship & Fellowship** from the Government of India with **All India Ranks of 56 & 137** out of 50,000 students who appeared each year *(2019, 2020)*

## Olympiads & Competitions

- Selected among the national **top 60** for the **Orientation Camp** twice through the **Indian National Astronomy Olympiad** and once through the **Indian National Physics Olympiad** *(2020, 2021)*
- Contributed to the **Asian Physics Olympiad 2022** by proofreading **experimental round questions** *(2022)*
- Evaluated **300+** answer scripts as a grader for the **Indian National Physics Olympiad** *(2022)*
- Among India's **top 300** students to qualify for the **Indian National Mathematical Olympiad** *(2019, 2020)*

## Research Projects

**Research Internship - Quantum Computing and Cryptography** *Summer 2023*
*Guide: Prof. Rahul Jain | Summer Internship* *National University of Singapore*

- Interpreted and presented multiple publications in the domains of **Quantum Computing** and **Quantum Cryptography**
- Understood the implications of applying **Classical Machine-Learning Algorithms** to **Quantum Many-Body Problems** with an attempt to improve Computational Complexity, studying classses like **BPP, BQP and P/Poly**
- Studied the value of **One-Way Functions** to Provide Secure Computation in the presence of **Quantum Adversaries**

**Analysis of Atmospheric High Energy Electromagnetic Flashes** *Spring 2023 - Ongoing*
*Guide: Prof. Varun Bhalerao, Prof. Vishal Dixit | Supervised Learning Project* *IIT Bombay*

- Analyzed and processed data from the **Cadmium-Zinc-Telleride Imager** aboard India's **X-ray** satellite **ASTROSAT**
- Determined frequencies of **High-Intensity, Milli-second Binned X-ray Events** during periods of **Earth Occultation** of the detector to make a **Statistical Prediction** on CZTI's ability to detect **High-Energy Atmospheric Flashes**

**Automatic Identification of Solar Flares in X-ray light curves** *Summer 2022 - Ongoing*
*Indian Space Research Organisation*

- Developed a robust pipeline to analyse and process X-Ray lightcurves **(1.55 to 12.4 KeV)** from the state-of-the-art solar observation payloads on **Chandrayaan-2 Orbiter (XSM)** and the upcoming **Aditya-L1 Satellite (SoLEXS)**
- Formulated an algorithm for estimation of the **Solar Background Intensity**, separating out regions with flares allowing for allowing for improved detection and analysis, especially for **Sub-A Class Solar Flares** (Low Intensity)
- Generated a catalog of **6266** solar flares between **2019 September 12 & 2022 November 4**, achieving an order of magnitude improvement over the current state-of-the-art for **Sub-A Class Solar Flares - manuscript in progress**

## Development Projects

**Cache Heirarchy Optimisation for SAT Solvers** *Spring 2023*
*Guide: Prof. Biswabandan Panda | Course Project: Computer Architecture and Digital Logic* *IIT Bombay*

- Utilised the **Champsim Simulator** to improve upon the **IPC** values for the **Cadical and Kissat SAT Solver Traces**
- Implemented and investigated various **LLC (Last Level Cache)** Replacement Policies, including **MRU, LRU, Random, and Re-Reference Interval Prediction**, to optimize **Cache Performance** and minimise **Cache Misses**
- Explored different cache inclusion policies such as **Inclusive, Exclusive** and **NINE** (Non inclusive non exclusive)
- Evaluated the effect of **Block Size** on cache performance by modifying the number of sets and ways while keeping the **Ratio, Product, or Associativity Constant**, effectively managing memory utilisation and maximising cache efficiency

**FastChat** *Autumn 2022*
*Guide: Prof. Kavi Arya | Course Project : Software Systems Lab* *IIT Bombay*

- Obtained **high throughput** of texts with **limited server resources** while ensuring **low latency** of individual message deliveries and **end-to-end encryption** in a network of (∼1000) clients interacting with each other
- Used **PostgreSQL database** to store information along with the **'ssl'** and **'socket'** Python libraries for communication
- Optimized **load balancing strategies** and **communication protocols** to minimize CPU and server memory usage
- Implemented efficient **end-to-end encryption** for **groups** and a system to store messages on the server for **offline users**

**Rail Planner** *Autumn 2022*
*Guide: Prof. Supratik Chakraborty | Course Project : Data Structures and Algorithms Lab* *IIT Bombay*

- Implemented data structures to efficiently plan and store **train stations, journeys, schedules** and **reviews**
- Set up **Hash Functions** to access stations and journeys, while using **BST & AVL Trees** to store the journeys
- Implemented the **Knuth-Morris-Pratt Algorithm** to search user reviews by keyword and a **Quicksort Algorithm** on **Linked Lists** to maintain a sorted list of journeys starting from or ending at any station
- Set up **Tries** to allow for **auto-completions** improving the user experience and **Heaps** to filter reviews by rating

## Other Projects

**Newtonian Orbital Mechanics Simulator** *Summer 2022*
*Summer of Science* *Maths and Physics club, IIT Bombay*

- Examined the **vectorial method** of analysing central force problems and simplifying multi body systems
- Tested the theory of **orbital dynamics** and its various constants with a simulation using the **Euler Integrator**
- Demonstrated **orbital maneuvers** in a simulation and learnt to use the theory to optimize the efficiency of transfers

**Astrophysical Animations** *Spring 2022*
*Team ANYmation, Astrophysics subsystem* *IIT Bombay*

- An **all student team of 20** developing physically accurate, space-based animations through procedural techniques
- Created a **Stellarium Model** to render a realistic projection of the **night sky** at a given date, place and time
- Built a system to Simulate **Keplerian orbits of satellites** around the earth, given orbital parameters
- Developed a program to simulate the **N-body problem** using the **Euler Integrator** given inital parameters

**Tic-Tac-Toe Game** *Autumn 2022*
*Guide: Prof. Kavi Arya | Course Project : Software Systems Lab* *IIT Bombay*

- Applied **Object-Oriented programming techniques** to create a 2 player Tic-Tac-Toe game in **Java**
- Implemented an **on-terminal** frontend with a shared backend made using **socket programming techniques**

**Bubble Shooter Game** *Autumn 2021*
*Guide: Prof. Parag Chaudhary | Course Project : Computer Programming and Utilization* *IIT Bombay*

- Applied **Modular Programming** and **Object-Oriented Programming** to implement a simple bubble shooter
- Utilized the **Chrono Library** for timing and **Vectors** to create **multiplying bubbles** of various sizes and colours

**Hand-Written Digit Recognition** *Summer 2020*
*Self Project* *Delhi Public School, Navi Mumbai*

- Used Numpy to **pre-process images** containing **multiple handwritten digits** and get outlines of individual digits
- Used a **Convolutional Neural Network** trained on the **MNIST hand-written digits dataset** for digit recognition
- Incorporated the **Tkinter library** for the GUI to make a more user-friendly system with resolution settings

## Positions of Responsibility

- **Institute Astronomy Secretary | Institute Technical Council, IIT Bombay** *(Summer 2023 - Ongoing)*
  - Leading a team of **8 Institute Conveners** to cater to the astronomy-based interests of **12000+ Students**
  - Organising the **Krittika Summer Projects**, an **8-week long** program aimed at exposing students to research in computational astronomy and received **100+** applications for **6 projects** headed by experienced mentors in the field
  - Ideating the development of the **IIT Bombay Astronomical Observatory** with an inital funding of **INR 1800K**
- **Teaching Assistant** - Conducted weekly tutorials for **30+** students for **PH111**(Classical Physics) *(Spring 2023)*
- **Department Academic Mentor, CSE** - Selected via a rigorous procedure consisting of **SoP, Peer Reviews and Interviews** to be part of a team of **32** out of **70+** applicants to guide **second-year students** *(Summer 2023 - Ongoing)*

## Technical Skills

| | |
|---|---|
| **Programming Languages** | C++, C#, Python, MATLAB, Java, Prolog, Haskell, Bash, SQL, MIPS Assembly |
| **Libraries and other software** | Pandas, Numpy, Scipy, Sed, GDB, Jupyter Notebooks, Docker, Blender, Unity |
| **Development** | HTML, CSS, Bootstrap, Javascript, Git, Latex, Doxygen, Sphinx, Markdown |

## Key Courses Undertaken

- **Computer Science:** Abstractions & Paradigms for Programming, Data Analysis & Interpretation, Discrete Structures, Design & Analysis of Algorithms, Computer Networks, Digital Logic & Computer Architecture, Logic for CS
- **Physics:** Classical Mechanics, Quantum Information and Computing, Quantum Physics, Electricity Magnetism

## Extracurricular Activities

- **Open Winner** of the **IIM Indore Inter-Varsity Debate Tournament** with a total participation of **33 two-member teams** from around the nation *(Autumn 2022)*
- Organising Committee - **14th, 15th IIT Bombay Debate Tournament**, India's largest BP tournament *(Winter 2022)*
- Completed 6 years of **French Education** with **100%** in the French Board Exam and **2 gold medals** in the **International French Language Olympiad** conducted by Silverzone *(2014-2019)*
- Winner of the **Basketball General Championship** among **8+** hostels competing over 2 weeks *(Winter 2022)*