Ashwin Abraham

Computer Science & Engineering
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Examination	University	Institute	Year	CPI/%
Graduation	IIT Bombay	IIT Bombay	2025	9.39
Intermediate	CBSE	Narayana e-Techno School, Chennai	2021	97.00%
Matriculation	CBSE	MVM School, Chennai	2019	93.60%

Pursuing **Honours** in **Computer Science** and a **Minor** in **Artificial Intelligence & Machine Learning**

Scholastic Achievements

Secured **Institute Rank 1** among **1400+** students and received the **Institute Academic Award** *2022*

Conferred the **AP (Advanced Proficiency) grade** in **3 courses**, given to less than **1%** of students *2021-22*

Secured **All India Rank 18** out of **140k+** candidates appearing for the **JEE Advanced** examination *2021*

Obtained **100 percentile** and **All India Rank 12** in the **JEE Main** and was the **State Topper** *2021*

Conferred the **KVPY Scholarship** by the Indian Govt, with **All India Rank 6** among **100k** candidates *2020*

Was awarded the **AP Scholar Award with Honors** by the *College Board* after scoring 5/5 in these exams: *Calculus BC (with AB subscore), Physics C Mechanics, Physics C Electromagnetism*, and *Chemistry* *2018-20*

Among the **top 39** students nationwide selected for OCSC **(International Junior Science Olympiad)** after clearing the *Indian National Junior Science Olympiad* and received the **NSEJS-INJSO Gold Medal** *2019*

Research Experience

Parametrized Verification of Concurrent Systems via View Abstraction — Summer 2023

Prof. Parosh Abdulla, Uppsala University; Prof. Ashutosh Gupta, Prof. Krishna S, IIT Bombay — *Research Internship*

- Read and implemented a paper describing a new approach to Parametrized Verification through *View Abstraction*
- Prepared a report on the paper, focusing on an algorithm that verifies the correctness of **concurrent algorithms** such as *Szymanski's Protocol* using the technique of View Abstraction, and presented the report to the authors of the paper
- **Implemented** and **optimized** the algorithm by using various data structures and algorithms to increase performance
- Used the **LLVM API** to the **clang C compiler** to write an LLVM pass that converts multithreaded C programs into an *abstract representation* as a transition system whose transitions may be either existentially guarded or universally guarded
- Integrated the verifying algorithm into the LLVM ecosystem and modified it to check the safety of these transition systems in order to verify the correctness of the multithreaded C program or produce counterexamples to prove unsafeness
- Targeting a publication in the near future that may be presented in major conferences such as POPL

Machine Learning in Chemistry — Spring 2023

Prof. Raghavan B Sunoj, IIT Bombay — *Research Project*

- Presented a **novel approach** inspired by **Reinforcement Learning algorithms** to identify the energy profile of the intermediates in a chemical reaction by using **Markov Chains** in order to simulate the evolution of a chemical reaction
- Read multiple papers on **Transfer Learning** applied to predict the efficacy of various catalysts in chemical reactions
- Reviewed ML protocols to predict the efficacy of asymmetric catalysts, utilizing techniques such as **SMOTE** (*Synthetic Minority Oversampling Technique*) to address issues such as the class imbalance in chemical data

Markov Decision Processes as Distribution Transformers: Safety Objectives — Autumn 2023

Prof. S Akshay, IIT Bombay — *Ongoing Research Project*

- Surveyed the literature on Markov Decision Processes as transformers of probability distributions and the associated safety problem on the trajectories of distributions generated given a policy on the MDP and an affine linear set of safe distributions
- Investigating the complexity of determining the existence of policies that keep the generated distributions within the safe set
- Also investigating algorithms to generate safe policies, if they exist, and the nature of the generated safe policies

Key Projects

Reinforcement Learning for a Chess Engine — Winter 2022 & Summer 2023

- **Mentored 15+ students** in a **Reading** and **Implementation** project on Reinforcement Learning
- Followed the book on RL by *Sutton & Barto* and prepared a report for mentees summarizing multiple chapters in the book
- Guided mentees and helped them implement various algorithms such as **Thompson Sampling** and the **Upper Confidence Bound Algorithm** to solve **Multi-Armed Bandits** by estimating the expected reward of each action
- Assisted mentees in implementing RL algorithms such as **Deep Q-Learning** to find **optimal policies** for various RL environments such as *Mountain Car*, *Lunar Lander* and *Atari: Breakout* from the **OpenAI gymnasium**
- Helped mentees in designing a **Chess Engine** using Deep Reinforcement Learning, similiar to *AlphaZero*

Generative Learning with Denoising Diffusion GANs **Autumn 2023**

Prof. Preethi Jyothi, IIT Bombay *Ongoing Course Project*

- Implementing a paper describing a novel approach to denoising images by using *denoising diffusion GANs*
- Aiming to solve the *Generative Learning Trilemma* by achieving high sample quality, mode coverage, and fast sampling
- Optimizing performance by using complex multimodal distributions in the denoising steps instead of Gaussian distributions

FastChat **Autumn 2022**

Prof. Kavi Arya, IIT Bombay *Course Project*

- Developed an **instant-messaging service** akin to **WhatsApp** with a **Terminal User Interface** and features such as **group chats**, **file transfer** and **offline messaging** using **PostgreSQL** and the socket programming libraries of Python
- Added **end-to-end encryption** between clients and encrypted all connections using a **Fernet encryption scheme**
- Achieved **high throughput** and **low latency** by adding **multiserver support** and Round Robin based **load balancing**

Cache Prefetcher and Hierarchy Optimization for Graph Analytics **Spring 2023**

Prof. Biswabandan Panda, IIT Bombay *Course Project*

- Implemented a paper describing a **Best Offset Hardware Prefetcher** that learnt the best offset based on recent accesses
- Reviewed various characteristics of traces associated with **Graph Processing Workloads** such as Dijkstra's Algorithm
- Implemented and compared various cache replacement policies such as LFU and LRU using the Champsim simulator
- Adjusted the cache size, replacement policy, and inclusion policy to optimize performance on Graph Processing Workloads

Rail Planner **Autumn 2022**

Prof. Supratik Chakraborty, IIT Bombay *Course Project*

- Developed a **command line application** in C++ for rail travel and journey planning which integrates checking trip prices, booking a journey, viewing and managing current journeys and trip reveiws, taking inspiration from real-world apps
- Implemented all the data structures and algorithms required for the application **manually**, including **Binary Search Trees**, **Hash Maps** and **Graphs** to store, retrieve and sort journeys from **large databases** in order to quickly respond to queries
- Utilized **Tries** in order to add predictive autocompletion and the **KMP Algorithm** for pattern matching
- Implemented various Graph Algorithms such as **Breadth First Search** and **Dijkstra's Algorithm** to find optimal routes

Other Projects

Statistical Analysis and Machine Learning **Autumn 2022**

Prof. Suyash Awate, IIT Bombay *Course Project*

- Used PCA to analyze images of handwritten digits from the MNIST Database and optimally reduce their dimensionality
- After this, implemented **Gaussian Discriminant Analysis** in order to build a handwritten digit classifier from scratch
- Implemented a PCA based algorithm that takes in a dataset of images of fruits and augment the dataset with **new images**
- Utilized MATLAB to sample points in the Euclidean Plane distributed according to various Multivariate Distributions

Memory Allocator **Winter 2022**

- Designed a memory allocator **from scratch** in C using only Linux system calls such as `mmap` and `munmap`
- Learnt about **virtual memory** and paging in Linux and implemented the **First-Fit Algorithm** to allocate memory
- Incorporated logic for merging and splitting memory blocks to optimize memory utilization and minimize fragmentation
- Created an API similiar to the standard `libc` API, with implementations of `malloc`, `calloc`, `realloc` and `free`

Telecommunication System Design **Spring 2023**

Prof. Bhaskaran Raman, IIT Bombay *Course Project*

- Built a physical layer for communication between two devices with **sound** as a medium using the **PyAudio** library
- Encoded the data into the **frequency** of the sound generated, in order to maximize throughput and minimize data loss
- Implemented an **Error Correcting Code** that could correct one-bit errors using the **Hamming 4/7 encoding**

Solving Puzzles Using SAT Solvers **Spring 2023**

Prof. Ashutosh Gupta, IIT Bombay *Course Project*

- Modelled the **Sliding Tile Puzzle** as a SAT Problem in Z3 Solver using optimal number of variables and clauses
- Used the Python API of the Z3 solver to check if the puzzle had a solution and to find the solution

x86 Assembly and CPU emulator **Autumn 2022**

- Studied the references given by the *CyberSecurity Club, IIT Bombay* to learn about **Assembly Programming**
- Implemented multiple elementary programs in **Assembly Language** using Intel Syntax for **64 bit x86 CPUs**
- Developed a **CPU Emulator** in C for an 8 bit CPU with 256 bytes of RAM based on the references given

Browser Based Chess Game **Spring 2022**

- Developed a **browser based game of Chess** using HTML, CSS and JavaScript utilizing the **fabric.js** library
- Implemented **Single Player** and **Two Player** modes and added support for Hexagonal Chess and Fischer Random Chess

Sudoku Solver **Autumn 2021**

- Developed and implemented an algorithm from scratch to solve a given puzzle of Sudoku based on backtracking
- Wrote a command line application in which the aforementioned algorithm was implemented in C++

Positions of Responsibility

Teaching Assistant **Autumn 2022 - Present**

Department of Computer Science, Department of Mathematics

- Was a Teaching Assistant for the following courses:

CS 228M	**Logic in Computer Science**	*Prof. Krishna S*
CS 230/231	**Computer Architecture (& Lab)**	*Prof. Biswabandan Panda*
MA 109	**Calculus I**	*Prof. Sanjoy Pusti, Prof. Madhusudhan Manjunath*
MA 111	**Calculus II**	*Prof. Niranjan Balachandran, Prof. Preeti Raman*
MA 106	**Linear Algebra**	*Prof. Dipendra Prasad, Prof. Jugal K Verma*

- Conducted weekly tutorial sessions for batches of **40+ students** for the courses MA 109, MA 111, MA 106 and CS 228M
- Created Lab Assignments on Assembly Programming and code profiling and optimization for CS 230/231
- Assisted in evaluation of answer scripts, grading and crib handling for the courses mentioned above

Associate Department General Secretary **2023 - Present**

Department of Computer Science and Engineering

- Represent the undergraduate student body of the department in the *Department Undergraduate Committee*, responsible for planning all academic activities in the Department, such as fixing the curriculum and the academic programme

Department Academic Mentor **2023 - Present**

Student Mentorship Program, IIT Bombay

- Served as a DAMP Mentor in the Department Academic Mentorship Program, providing guidance, support and assistance to sophomore students and above in order to facilitate the academic and personal development of the students

Academic Coordinator, Student Support Services **2022 - 23**

Undergraduate Academic Council, IIT Bombay

- Catered to the academic demands of over 5000 undergraduates across all departments in IIT Bombay, by compiling and releasing resources for courses, conducting help sessions, assisting in the selection of Teaching Assistants, and so on

Class Representative **2021 - 22**

- Represented the class to the Faculty Members and helped disseminate information and schedule examinations and classes

Relevant Courses Undertaken

- AI & Machine Learning†
- Logic for Computer Science
- Discrete Mathematics
- Optimization
- Quantum Computing
- Quantum Physics
- Programming Paradigms†
- Reinforcement Learning
- Automata Theory
- Data Analysis and Interpretation
- Software Systems Lab
- Computer Architecture†
- Operating Systems†
- Computer Networks†
- Game Theory & Mech. Design
- Applied Algorithms
- Algorithm Design and Analysis
- Data Structures and Algorithms†
- Calculus
- Linear Algebra
- Differential Equations

Courses labelled with † had separate theory and lab components

Technical Skills

Programming Languages	C/C++, Python, Java, Bash, LaTeX, MATLAB, x86 Assembly, Prolog, Sed, Awk
ML and Data Science	TensorFlow, Keras, PyTorch, scikit-learn, NumPy, Pandas, MatPlotLib
Development	Jupyter Notebook, Doxygen, Sphinx, HTML5, CSS, JavaScript, Bootstrap, LLVM

Extracurricular Activities

Awarded **2nd** prize and a cash prize of **Rs 3000** in *CodeWars v1: Virus Wars*, India's first Bot Programming Contest conducted by the Web and Coding Club, IIT Bombay *Jan 2022*

Coinvented an *aerosol trapping device* (**patent pending**) to prevent spread of COVID 19 during surgeries *2020*

Coinvented an *every-day use consumer mask* (**patent pending**) with anti-fog measures allowing transparency, facial recognition, and sensors allowing use while dining and during social events *2020*

Mentored and guided JEE Aspirants of 2022 and 2023 batches from across the nation *2021-22*

Volunteered with the not-for-profit *Eye Research Centre, Chennai* to combat preventible blindness *2017-19*

Selected for **International Level** of the *Wordsworth International Spelling Bee* *2011*