

Pursuing a **Minor** degree in **Artificial Intelligence** and **Data Science** from **C-MInDS, IIT Bombay**

## SCHOLASTIC ACHIEVEMENTS

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- Achieved **99.81 Percentile** in **JEE-Main** out of over 1 million candidates (2021)
- Achieved **99.14 Percentile** in **JEE-Advanced** out of over 0.14 million candidates (2021)
- Achieved **AP grade** for excellent performance in **PH 108 - Basics of Electricity & Magnetism** (2022)
- Secured a **Branch Change** to **Computer Science** department on the basis of academic performance (2022)
- Secured **AIR 275** in the prestigious **KVPY SX** and awarded fellowship by **IISc Bangalore** (2021)

## WORK EXPERIENCE

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### Applied AI Researcher at Brance Technologies

(Summer 2023)

- Developed and implemented performant chatbot systems using **vector embeddings** for data retrieval and **Large Language Models** for question-answering, resulting in significantly improved user experience and engagement
- Utilized **Haystack** framework and **FAISS** to efficiently index and store proprietary data, leveraging **vectorDBs** to store the embeddings. Utilized **Hugging Face models** to form the entire **indexing and retrieval pipeline**
- Included **document reranking** resulting in improved relevance and accuracy of the retrieved information for chatbot
- Implemented **Locality-Sensitive Hashing (LSH)** to create a highly **performant caching system** to cache user queries that utilizes **semantic search**, optimizing the speed, accuracy, and efficiency of data retrieval for chatbot
- Leveraged **Nginx** and **FastAPI** on an **AWS EC2** instance to ensure seamless communication, and reduced latency for the chatbot system. Utilized **async calls** and FastAPI's scalability for smooth data retrieval and processing

## KEY PROJECTS

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### Stable Diffusion from Scratch

(Summer 2023)

*Self Project*

- Used **PyTorch** to independently develop and implement **each component** of a Stable Diffusion model on smaller datasets before using the Hugging Face's **diffuser library** to implement the final diffusion model on a larger dataset
- Implemented a **Variational Autoencoder (VAE)** and trained it on the Fashion MNIST dataset using **reconstruction loss** and **KL-Divergence loss**, enabling accurate reconstruction of inputs and latent space interpolation
- Implemented a **Diffusion U-Net** with **timestep embeddings** and **self-attention** and used it to implement both unconditional and conditional **DDPM** (Denoising Diffusion Probabilistic Models) on MNIST and CIFAR-10 datasets
- Used various scheduling techniques like **DDIM**, **LMSDiscrete** and **PNDM** etc. to improve speed of the generations
- Implemented **latent diffusion** by utilizing the diffuser's VAE to **encode images** to latent representations, and subsequently trained a **DDPM** on these latents using the LSUN churches datasets to generate high-quality images
- Used various metrics like **FID** (Fréchet Inception Distance) scores to evaluate the quality of the generated images

### Discrete Event Simulator for Bitcoin Network

(Spring 2023)

*Guide: Prof. Vinay J. Ribeiro | Course Project : Introduction to Blockchains and Smart Contracts*

*IIT Bombay*

- Implemented a discrete event simulator for the Bitcoin Network and **analyzed the forking** and length of the main chain. Additionally, simulated **selfish mining** and **stubborn mining** attacks on the network by an adversary node
- Analyzed the **adversary's relative profitability** under various factors like hashing power and network latency etc.
- Utilized the **Networkx** library to create a connected **P2P network** and generated visual representations of the blockchain. Used the **SimPy** library to maintain a **global clock** and simulate the **mining and transaction events**

### Layer 2 DAPP for Lightning Network Simulation

(Spring 2023)

*Guide: Prof. Vinay J. Ribeiro | Course Project : Introduction to Blockchains and Smart Contracts*

*IIT Bombay*

- Developed a Layer 2 DAPP on the **Ethereum blockchain**, utilizing **Ganache** and **Truffle** to set up a local Ethereum node. Implemented the smart contract in **Solidity**, enabling the execution of transactions within the Layer 2 DAPP.
- Developed a simulation model of **Lightning Networks**, a Layer 2 scaling solution for the Ethereum blockchain
- Ran the simulation using an external Python script to perform various transaction scenarios and analyze their outcomes

## KYC-Website

(Summer 2023)

### Self Project

- Developed and implemented KYC-Website, a secure web application utilizing **Node.js**, **Express.js**, and **MongoDB Atlas** for KYC verification, mimicking the KYC requirements for banking and financial institutions
- Utilized the **easy-ocr library** for **ID information extraction** and the **face-recognition library** for **real-time face matching** to automate the KYC verification process, ensuring swift verification without human intervention
- Learned about **full-stack development** by utilizing technologies such as **Bootstrap**, **EJS**, **Passport.js** to create a user-friendly and responsive web application with secure authentication, form validation and user sessions
- Utilized **FastAPI** to wrap and integrate the **machine learning components** of the project, ensuring seamless communication and efficient handling of requests between the web application and the ML API servers

## FastChat

(Autumn 2022)

Guide: Prof. Kavi Arya | Course Project : Software Systems Lab

IIT Bombay

- Developing a messaging software with **end-to-end encryption** by using **RSA+AES** to encode the messages and both group chat and individual chat support using **python socket library** and **PostgreSQL** database
- Implementing a **load balancer** with **least connect strategy** using bash to distribute load among multiple servers, and focusing on obtaining **high throughput** while using only limited resources dedicated for the servers
- Used **bash** scripts to simulate common messaging patterns and calculate **throughput** and **latency** of the system

## OTHER PROJECTS

### Deep Learning

(Summer 2023)

#### Self Project

- Implemented and trained **Google's Deeppose**, a deep learning model for **human pose estimation** on LSP dataset
- Implemented a **Cycle-GAN** architecture for image-to-image translation, enabling conversion between two classes
- Trained an agent to play **lunar lander** game using **Deep Q-Network (DQN)**, a reinforcement learning algorithm
- Implemented **neural style art transfer** using **VGG19** to combine the content of one image with the style of another
- Implemented the **U-Net** architecture and applied it to CARLA, a self-driving car dataset for **semantic segmentation**
- Implemented **ResNets** from scratch and utilized **transfer learning** for image classification and recognition tasks

### Z3 SAT Solver

(Spring 2023)

Guide: Prof. Ashutosh Gupta | Course Project : Logic for Computer Science

IIT Bombay

- Implemented and utilized **SAT solving techniques**, specifically leveraging the **Z3 theorem prover** in Python, to formulate an effective strategy for the game Sliding-Solver and also handle the case of **unsatisfiability** for the game

### L-TAGE Branch Predictor

(Spring 2023)

Guide: Prof. Biswabandan Panda | Course Project : Digital Logic Design and Computer Architecture

IIT Bombay

- Implemented the L-TAGE branch predictor using **champsim**, a state-of-the-art simulator in **C++** and analyzed the performance of the predictor on various **benchmarking traces** like gcc, leslie3d, milc, perlbench and zeusmp

### SwarComm

(Spring 2023)

Guide: Prof. Bhaskaran Raman | Course Project : Computer Networks Lab

IIT Bombay

- Implemented the **physical layer** and **link layer** of the **OSI stack** by utilizing eight distinct frequencies of sound to represent octal bits for efficient data transmission. Used **Hamming codes** for error correction and reliable transfer

### Railway Planner

(Autumn 2022)

Guide: Prof. Supratik Chakraborty | Course Project : Data Structures and Algorithms Lab

IIT Bombay

- Designed a simplified version of a railway planner using various data structures such as **Heaps**, **Hash Tables**, **Tries** and **BSTs** and analyzed the space & time complexity to study the properties of various data structures in **C++**

## TECHNICAL SKILLS

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|------------------|--|
| Programming      | C, C++, Python, Bash, Solidity, Java, JavaScript, VHDL, Sed, Awk                                     |
| Data Science     | Tensorflow, Pytorch, Keras, Trax, Scikit-learn, OpenCV, NumPy, Pandas, Matplotlib                    |
| Software & Tools | MATLAB, Git, L <sup>A</sup> T <sub>E</sub> X, Docker, Wireshark, Z3, Doxygen, Sphinx, Nginx, FastAPI |
| Web Development  | HTML5, CSS, JavaScript, Bootstrap, jQuery, Node.js, Express.js, SQL, MongoDB                         |

## KEY COURSES UNDERTAKEN

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|------------------|--|
| Mathematics      | Calculus, Linear Algebra, Discrete Structures, Differential Equations, Optimization Models, Logic for Computer Science, Game Theory and Decision Analysis  |
| Computer Science | Data Structures and Algorithms <sup>#</sup> , Data Analysis and Interpretation, Software Systems Lab, Computer Networks <sup>#</sup> , Computer Architecture <sup>#</sup> , Design and Analysis of Algorithms, Introduction to Blockchains Cryptocurrencies and Smart Contracts, Computer Vision |

## EXTRACURRICULAR

- Mentored two groups of students during the **SoC (Summer of Code)** program conducted by **WNCC**, **IITB** guiding them through **deep learning projects** and assisting in the implementation of cutting-edge research papers (2023)
- Successfully completed one year under **National Sports Organization(NSO)** in **Chess** at IIT Bombay (2022)
- Pitched a **Business Model Canvas** for a startup in the health sector which entailed making online ambulance bookings, for the EnB Buzz competition conducted by the **Entrepreneurship cell of IIT Bombay** (2021)
- Worked in a team of 4 to make an ESP32 **WiFi-controlled** bot for **XLR8** conducted by **ERC**, **IITB** (2022)