

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)
- Secured **All India Rank 1207** in **JEE-Advanced** out of over 0.14 million candidates (2021)
- Secured **AP grade** for excellent performance in **PH 108**, awarded to 27 out of over 1300 students (2022)
- One of the **17 out of 1400+** students to secure a **Branch Change** to the department of **CSE** (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 **retrieval pipeline**, including **document reranking**, resulting in improved relevance and accuracy of the retrieved information for chatbot responses
- 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** architecture with **timestep embeddings** and **self-attention** and used it to implement both unconditional and conditional **DDPM(Denoising Diffusion Probabilistic Models)** on the **CIFAR-10** dataset. Also used **various sampling techniques** to improve the quality of the generated images
- 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 and bedrooms datasets** to generate high-quality images. Used **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 DES 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 and analyzed the **adversary's relative profitability** under various factors such as hashing power, number of nodes and 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/Truffle** to set up a **local Ethereum node**. Implemented the smart contract in **Solidity**, enabling the execution of transactions within the Layer 2 DAPP and facilitate the simulation 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

## FastChat

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

(Autumn 2022)

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

## KYC-Website

Self Project

(Summer 2023)

- 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**

## Deep Learning

Self Project

(Autumn 2022)

- Made a **convolutional neural network** to classify images of handwritten digits using **MNIST** dataset and also made a **GUI** to draw digits using **python Tkinter** and classify them using the model. Made three different models using **TensorFlow Core**, **Keras Functional API** and **PyTorch** and compared their performance
- Made many different types of **CNNs** to classify various types of data such as **Traffic signs recognition**, **Crack detection**, **Smile detection**, **Hand sign recognition** using **PyTorch** and **Keras Sequential API**
- Successfully implemented **transfer learning** to train a **pretrained MobileNetV2** to classify images of **alpacas** and used **data augmentation** like random rotation and flipping resulting in a highly accurate model
- Implemented **ResNet50's architecture** from scratch using **Keras Functional API** and trained it on a hand sign dataset to classify images of 6 different classes. Compared its performance to a **pretrained ResNet50 model**

## OTHER PROJECTS

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### Rail Planner

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

(Autumn 2022)

IIT Bombay

- Designed a simplified version of a railway planner using various data structures and analyzed the space & time complexity and the efficiency to demonstrate the **properties of different data structures in C++**
- Stored trains as a dictionary using **Hash Tables** and devised algorithms for fastest possible journeys
- Used **BSTs and then AVL trees** for quick searching using the journey codes and used **Tries** to implement the autocomplete feature while searching for station names and added a feature to accept reviews for journeys
- Used **Quicksort** to order trains by day and time, implemented the **KMP-string matching algorithm** for allowing review searches by using keywords and implemented **Heaps** to allow filtering the reviews by their rating

### Z3 SAT Solver

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

(Spring 2023)

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

### Champsim Branch Predictor

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

(Spring 2023)

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

### Swarcomm

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

(Spring 2023)

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

## 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 NodeJS, ExpressJS, SQL, MongoDB

## KEY COURSES UNDERTAKEN

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

(<sup>#</sup> Theory + Lab)

## EXTRACURRICULAR

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- 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)