Eeshaan Jain

4th year undergraduate, Electrical Engineering, IIT Bombay

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Education

École Polytechnique Fédérale de Lausanne — *Switzerland*

Semester Exchange in Computer Science — *Aug. '22 - Feb. '23 (Expected)*

Indian Institute of Technology Bombay (English) — *India*

B.Tech in Electrical Engineering (EE) with M.Tech in Machine Intelligence and Data Science (CPI: $9.62/10$) — *Jul. '19 - May '24 (Expected)*

Scholastic Achievements

2022 **Institute Academic Prize 2022**, Awarded for being in the top 2 ranks in Electrical Engineering

2022 **Department Rank 2**, Out of 79 students in the Dual Degree Programme, Electrical Engineering

2021 **Institute Academic Prize 2021**, Awarded for being in the top 2 ranks in Electrical Engineering

2020 **AP Grade**, Awarded to the top 2% students in Differential Equations-II and Physical Chemistry

2019 **All India Rank 120**, JEE Main 2019 out of 1.2 million candidates

2019 **All India Rank 355**, JEE Advanced 2019 out of 245,000 qualified candidates

2019 **Top 300 across India**, Indian National Chemistry and Astronomy Olympiads conducted by IAPT, India

2018 **All India Rank 100**, Kishore Vaigyanik Protsahan Yojana organized by the Government of India

2018 **National Top 1%**, National Standard Examinations in Physics and Chemistry conducted by IAPT, India

2018 **State Top 1%**, National Standard Examinations in Astronomy conducted by IAPT, India

Professional Experience

MACHINE LEARNING RESEARCHER — *Mumbai, India*

In collaboration with Google AI, the University of Texas at Dallas and IIT Bombay — *May 2022 - Sep. 2022*

- Designed a novel **non-adaptive subset selection framework** for generalizing **efficient learning** over several neural architectures
- Introduced a **GNN** and **attention-based** model encoder for crude **approximation** of outputs over a set of architectures
- Utilized **combinatorial optimization** for subset selection on the novel trainable and differentiable subset selectors
- Demonstrated that our approach constantly **outperformed** other non-adaptive and adaptive subset selection approaches on various datasets and subset sizes in terms of **accuracy**, **subset selection time** and **memory consumption**
- Used the approach for **architecture ranking** and selected the **best-suited neural architecture** from a pool of architectures

ARTIFICIAL INTELLIGENCE ENGINEER — *Sapporo, Japan*

AWL, Inc. Japan - Core Artificial Intelligence team — *May 2022 - Jul. 2022*

- Surveyed optimization frameworks based around **model compression, quantization-based training** and **inference speed-up**
- Implemented **hardware-optimized operations** and routines on CPUs using **Apache TVM** to bring down single-image inference times on low-power devices by **8**× without hurting the metrics of the outputs
- Utilized the **TensorRT** and **DLA** GPU-based frameworks along with CPU fallbacks to speed up batched-inference on Jetson GPUs

Research Projects

EFFICIENT MATROID-CONSTRAINT-BASED SUBMODULAR MAXIMIZATION — *Course Project: Optimization for Machine Learning*

Guide: Prof. Ganesh Ramakrishnan, Dept. of Computer Science, IITB — *Mar. 2022 - May 2022*

- Worked on **efficient** greedy algorithms for **maximization of submodular functions** under **matroid** constraints
- Implemented the **Continuous-Greedy** and **Accelerated Continous-Greedy** algorithms in SUBMODLIB
- Modified the **Pipage-Rounding** subroutine for **efficient translation** of fractional solutions to discrete subsets
- Implemented the **Submodular Welfare Problem** and, **Separable** and **Generalized Assignment Problem** in SUBMODLIB

POST-HOC OUT-OF-DISTRIBUTION DETECTION — *Course Project: Advanced Machine Learning*

Guide: Prof. Sunita Sarawagi, Dept. of Computer Science, IITB — *Mar. 2022 - May 2022*

- Worked on a **new scoring function** to generalize across OOD settings and **improving the ID-OOD gap** using marginless loss functions
- Introduced a scoring function based on the assumption of a **Dirichlet distribution** on the DNN's softmax-ed logits for OOD detection and showed that it could be asymptotically interpreted as an **ensemble** of two positive scoring functions
- Showed that the score already **outperformed** other OOD methods on multiple datasets on the basis of **FPR95**, **AUROC** and **AUPR**
- **Reduced** the number of hyperparameters to tune by demonstrating the **efficacy** of marginless loss functions for the task

ESTIMATION OF EPIDEMIC STATE USING GRAPH NEURAL NETWORKS

Course Project: Learning with Graphs

Guide: Prof. Abir De, Dept. of Computer Science, IITB

Sep. 2021 - Nov. 2021

- Worked on determination of the **state of epidemic spread** in a small-world network using **GCNs**
- Generated **random networks** using the Erdős–Rényi-Gilbert, Watts-Strogatz, and Barabási–Albert models for our dataset
- Implemented the **SIR** contagion model, treating the epidemic as a CTMC, on our graphs to get a **spatio-temporal** dataset
- Performed **node classification** (S/I/R) using **Graph Neural Networks** by monitoring only a **small subset** of nodes (15% - 25%)

NON-SMALL CELL LUNG CANCER DETECTION AND MUTATION PREDICTION

Guide: Prof. Amit Sethi

Jan. 2021 - Apr. 2021

- Trained **Inception v3** on whole-slide images obtained from TCGA to **classify** the tissue cancer into LUAD, LUSC or non-cancerous
- Obtained an **AUC score** of 0.97 on cancer classification comparable to the predictions obtained by visual inspection from **pathologists**
- Further trained the network to predict 6 of the most common **mutated genes** in **LUAD** obtaining a **maximum AUC score** of 0.84

Course Projects

IMPROME - IMAGE PROCESSING MADE EASY

Course Project: Image Processing

Guide: Prof. Amit Sethi

Aug. 2021

- Developed a **graphical user interface** using the **PyQt** framework in Python to perform image processing operations
- Reviewed literature on **color spaces**, **histogram specifications**, **intensity transformations** and **frequency transformations**
- Implemented image processing algorithms such as vectorized **convolutions**, **transformations** and **equalizations** from scratch

NEURAL MACHINE TRANSLITERATION

Course Project: Machine Learning

Guide: Prof. Biplab Banerjee

Mar. 2021 - May 2021

- The goal of the project was to create an interface to facilitate **transliteration of text** in images from one language to another
- Explored and implemented various **sequence to sequence** machine transliteration models to convert a piece of Hindi text into English
- Pipelined the transliteration model with **optical character recognition** techniques using EasyOCR to extract Hindi text from an image

STOCK MARKET ANALYSIS AND PRICE PREDICTION

Course Project: Programming for Data Science

Guide: Prof. Amit Sethi, Sunita Sarawagi

Mar. 2021 - May 2021

- Studied the performance of seven sectors of the **Indian stock market** during the first wave of **COVID-19** from Feb 2020 to Jun 2020
- Performed **exploratory data analysis** on the NIFTY sectoral indices and compared them using **technical indicators** such as RSI
- Compared performance of **sequential neural network architectures** such as LSTMs and 1D CNNs to **predict stock market prices**
- Received a **special mention** and credited as the **most outstanding project** amongst 40+ projects in the field of Data Science

DIGITAL CIRCUIT DESIGN IN QUARTUS

Course Project: Digital Systems

Guide: Prof. Maryam Shojaei Baghini

Jan. 2021 - Apr. 2021

- Implemented a 16 bit **Kogge Stone** adder/ subtractor, arithmetic right **shift** and a **clock divider** on the Krypton CPLD-based board
- Emulated the **blinking taillights** of the Ford Thunderbird by modeling the blinking sequence with a **finite state machine**

WORKING WITH CISC AND RISC MICROPROCESSORS

Course Project: Microprocessors

Guide: Prof. Dinesh Sharma, Prof. V Raj Babu

Jan. 2021 - Apr. 2021

- Implemented **software keyboard scanning** on the Intel 8051 and Mini-MIPS processor using FSM with a keystroke interval of 50ms

METHODS IN NATURAL LANGUAGE PROCESSING

Course Project: Natural Language Processing

HSE Russia, Coursera

May 2020 - Jun. 2020

- Performed **semantic analysis** using linear models (multi-label classifiers) on StackOverflow for predicting tags given questions
- Studied about **language models**, **probabilistic Markov models** and performed named-entity recognition on Twitter using LSTMs
- Reviewed statistical machine translation, encoder-decoder models and summarization using **pointer-generator networks**

Other Projects

HYPERLOOP POD SUBSCALE PROTOTYPE DESIGN

Team Hyperloop IITB

Jan. 2020 - Dec. 2020

- Applied knowledge acquired on **I2C** and **CAN** communication protocols to the Hyperloop communication systems
- Qualified in the **top 5** university teams internationally for the finals of the **European Hyperloop Week** (EHW 2021)

IMAGE TO IMAGE TRANSLATION - SKETCH TO COLOR

Seasons of Code - Winter, IIT Bombay

Apr. 2020 - Aug. 2020

- Surveyed literature on **generative adversarial networks** and image-to-image translation using **conditional** adversarial networks
- Implemented a **conditional-GAN** which accepts **sketched** image and predicts its **colored version** without knowing the ground truth

VIRTUAL REALITY GAME DEVELOPMENT

Tinkerer's Lab, IIT Bombay

Apr. 2020 - Aug. 2020

- Headed the **animation team** and developed a first person virtual reality game in **Unity** Game Engine and **Blender** 3D software

AUTONOMOUS GARBAGE COLLECTING BOT

Institute Technical Summer Project, IIT Bombay *Apr. 2020 - Aug. 2020*

- Designed an **autonomous** garbage collecting bot which can **classify**, **detect** and **collect** plastic, cardboard, metal and wrappers
- Used **YOLO** for object detection, **ROS** for simulation, and designed a custom gripper for **palming action** to pick the garbage
- Declared as one of the **top 3** projects overall out of more than 60 projects that were submitted in ITSP 2020

Skills

Languages	Python, Scala, C++, Julia, HTML, CSS, Javascript
Machine Learning	PyTorch, PyTorch-Geometric, NLTK, Scikit-Learn, OpenCV, TVM, TensorRT
Softwares	Scilab, MATLAB, Quartus, Keil, Blender, Git, AutoCAD, SolidWorks, GNU Radio, Spice
Python Libraries	NumPy, Pandas, Matplotlib, Seaborn, SciPy, Qiskit, SymPy, PyQt5, JAX, NetworkX, OpenCV

Key Courses Undertaken

Machine Learning	Programming for Data Science, Introduction to Machine Learning, Learning with Graphs, Foundations of Intelligent Learning Agents, Advanced Machine Learning, Optimization for Machine Learning, Natural Language Processing†
Communication & Signal Processing	Probability and Random Processes, Signal Processing, Microprocessors, Communication Systems, Digital Signal Processing, Image Processing, Markov Chains*, Information Theory and Coding†, Automatic Speech Processing†
Math & Physics	Calculus, Linear Algebra, Differential Equations-II, Complex Analysis, Quantum Physics
Computer Science	Computer Programming and Utilization, Operating Systems, Algorithms†, Functional Programming†
Online Courses	Deep Learning Specialization (IIT Madras), Natural Language Processing (HSE Russia), Managing the Company of the Future (London Business School), Geometric Learning, Differential Privacy, Quantum Computing and Information

∗ *Ongoing* † *taken at EPFL*

Positions of Responsibility

CLASS REPRESENTATIVE

Electrical Engineering Department *Sep. 2019 - Ongoing*

- Responsible for **establishing communication** between professors, functionaries, other academic staff, and the class of 160 students
- Suggested measures that instructors could adopt to facilitate **better learning experience** in the mode of **online teaching**

UNDERGRADUATE TEACHING ASSISTANT

Computer Science: CS769: Optimization for Machine Learning

Mathematics: MA108: Differential Equations, MA207: Partial Differential Equations *Mar. 2021 - Nov. 2021*

- Conducted **weekly tutorial sessions** for a batch of 50 freshmen and helped them in the course through **personal interaction**
- **Assisted** the instructor in the course by conducting tutorials, proctoring exams and evaluating examinations and periodic assessments

STUDENT PROJECT MENTOR

Institute Technical Summer Project & Summer Of Science, IIT Bombay *Apr. 2021 - Sep. 2022*

- **Guided** students, **reviewed** their progress and suggested related literature in their summer project on Automated Sign Language Translation using Mechanical Gloves, which won the first **first-prize** overall among 70 projects
- **Mentored** students and reviewed their reports in their summer learning project on the topics **Deep Learning** and **Graph Theory**

PYTHON COURSE INSTRUCTOR

PyCK: Python is Cool, Kids!, Web and Coding Club, IIT Bombay *May 2021 - Jul. 2021*

- A part of the team of students to conduct a summer course on **Python Programming**, with **1000+** enrolments
- Delivered **biweekly lectures** covering various topics in Python, held frequent **doubt sessions** and helped in **guided projects**

CONVENER

Chemistry Club *May 2020 - Jun. 2021*

- Contributed to setting up the **foundations** of the club and further for the organization of future events
- Organized and conducted **Rascionix**, a national chemistry competition with **200+ participants** from all around India

Extracurricular Activity

AISRG	Started a student reading group at IIT Bombay on the topic of upcoming Artificial Intelligence	2022
Volunteer	Conducted sessions at IIT Bombay on teaching how to solve the 3x3 Rubik's Cube	2021
Chemenigma	Represented IIT Bombay at Chemenigma, hosted by IISc Bangalore and stood 1st overall	2021
Chess	Completed a year-long professional course in Chess under National Sports Organization (NSO), IITB	2019-2020
LIMIT	Qualified for the LIMIT examination and attended a camp in ISI Bangalore about abstract mathematics	2019
Rubik's Cube	Awarded the fastest cuber in Cubing Fever 2k16 - a district level speedcubing competition	2016
Debate	Represented the school in various inter-school debates and won the best speaker award twice	2016
Vedic Maths	Completed all six levels of Speed Arithmetic under IPA and stood 2nd in their state-level competition	2015