# EESHAAN JAIN

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## Education

**École Polytechnique Fédérale de Lausanne** — Lausanne, Switzerland
*PhD in Computer Science under Prof. Charlotte Bunne, AI in Molecular Medicine Lab* — *Sep '24 – Ongoing*
*Semester Exchange in Computer Science* — *Sep '22 – Feb '23*

**Indian Institute of Technology Bombay** — Mumbai, India
*Dual Degree: B.Tech in Electrical Engineering and M.Tech in Artificial Intelligence (Grade: **9.73/10.0**)* — *Jul '19 – Jun '24*

## Publications

1. **Eeshaan Jain** et al. "**Graph Edit Distance with General Costs Using Neural Set Divergence**", at NeurIPS 2024.
2. **Eeshaan Jain** et al. "**Efficient Data Subset Selection to Generalize Training Across Models: Transductive and Inductive Networks**", at NeurIPS 2023.
3. **Eeshaan Jain** et al. "**Graph Edit Distance Evaluation Datasets: Pitfalls and Mitigation**", under review.
4. **Eeshaan Jain** et al. "**Solving Graph Combinatorial Problems via Differentiable Permutation Functions**", under review.

## Scholastic Achievements

- Awarded the **Undergraduate Research Award** for the most outstanding Bachelor's Thesis in Electrical Engineering (*2023*)
- Awarded **Google Conference Scholarship (3000$)** and **NeurIPS Scholar Award** for attending NeurIPS (*2023*)
- Awarded the **Institute Academic Prize** for being the top 2 ranks in Electrical Engineering (*2021 & 2022*)
- **Department Rank 1** out of 79 students in the Dual Degree Programme, Electrical Engineering (*2020 – 2022*)
- Awarded the **AP Grade** for **outstanding performance** in Partial Differential Equations and Quantum Chemistry (*2021*)
- Secured an **All India Rank of 355** in JEE Advanced among 0.25 million candidates (*2019*)
- Secured an **All India Rank of 120** in JEE Mains (Engineering) among 1.3 million candidates (*2019*)
- Ranked **top 300 across India** and appeared in the Indian National Chemistry and Astronomy Olympiads (*2019*)

## Summer Schools

**Eastern European Machine Learning Summer School (Google Deepmind)** — *Novi Sad, Serbia (Jul'24)*
*Best Poster Award: Efficient Data Subset Selection to Generalize Training Across Models: Transductive and Inductive Networks*

**Machine Learning for Drug Discovery Summer School (Recursion)** — *Montreal, Canada (Jun'24)*
*Hackhaton Winner: Kinase Selectivity Chalenge - Predict interactions between proteins and molecules*

## Industry Experience

**Efficient Data Subset Selection to Generalize Training Across Models** — *May '22 – May '23*
*Google Research, Bachelor's Thesis-I with Prof. Abir De, Prof. Rishabh Iyer (UT Dallas)* — *Remote, IIT Bombay*

- Introduced a **GNN** and **attention-based** model encoder for crude **approximation** of outputs over a set of architectures
- Relaxed the **combinatorial optimization** objective for subset selection on the novel trainable & differentiable selectors
- Demonstrated that our approach constantly **outperformed** other methods in terms of **accuracy**, **subset selection time** and **memory consumption** and in **AutoML** tasks such as Neural Architecture Search and Hyperparameter Optimization

**Scalable Inference on Low-Power Devices via Hardware Optimization** — *May '22 - Jul '22*
*AWL, Inc. Japan: Core Artificial Intelligence Team along with Sony Japan* — *Sapporo, Japan*

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

## Research Experience

**End-to-end Differentiable Approaches for Combinatorial Optimization on Graphs** — *Jul '23 - Jun '24*
*Dual Degree Project, Guide: Prof. Abir De, Prof. Soumen Chakrabarti* — *IIT Bombay*

- Designed end-to-end differential approaches to APX-Hard **combinatorial optimization** problems on graphs
- Released **new** and **unbiased** datasets for learning **reasoning algorithms** on graphs via distant supervision

**Generalization Bounds and Explainability of Graph Neural Networks** — *May '23 - Aug '23*
*Research Assistant, Guide: Prof. Vikas Garg, Amauri H. Souza* — *Aalto University*

- Derived stronger and tighter **generalization bounds** for different subclasses of message-passing networks
- Connected notions of **robustness**, **generalizability** and **faithfulness** of explanations with extensions to temporal graphs

**Fairness Audits of Black Box Neural Networks** *Jan '23 - May '23*

*Bachelor's Thesis-II, Guide: Prof. Abir De* *IIT Bombay*

- Approximated fairness of blackbox models through **near-optimal querying** of data points under budget constraints
- Devised an **RL-based algorithm** to sample points through a VAE coupled with a **Gaussian Process** surrogate model
- Introduced a new fairness metric called **Disparity** bridging group and individual fairness notions, and formulated a disparity-minimization-based **greedy optimization** problem to **minimize post-audit manipulation**

## Technical Projects

**Post-Hoc Out-of-Distribution Detection** *Mar '22 - May '22*

*Guide: Prof. Sunita Sarawagi (CS 726: Advanced Machine Learning)* *IIT Bombay*

- 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 using **FPR95**, **AUROC** and **AUPR**
- **Reduced** the number of hyperparameters to tune by demonstrating the **efficacy** of marginless loss functions for the task

**Efficient Matroid-constraint-based Submodular Maximization** *Mar '22 - May '22*

*Guide: Prof. Ganesh Ramakrishnan (CS 769: Optimization for Machine Learning)* *IIT Bombay*

- Implemented the efficient **Continuous-Greedy** and **Accelerated Continous-Greedy** algorithms in SUBMODLIB to maximize submodular functions under a matroid constraint with $(1 - 1/e - \epsilon)$ guarantees
- 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**

**Sparse Estimation of Epidemic State using Graph Neural Networks** *Sep '21 – Nov '21*

*Guide: Prof. Abir De (CS768: Learning with Graphs)* *IIT Bombay*

- Generated random and **small-world networks** using the Erdös–Rényi, Watts-Strogatz, and Barabási–Albert models
- 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 **GCNs** by monitoring only a **small subset** of nodes (15% - 25%)

## Technical Skills

**Programming Languages**: Python, C++, Scala, Julia
**Machine Learning**: PyTorch, PyTorch-Geometric, NLTK, Scikit-Learn, OpenCV, TVM, TensorRT

## Key Coursework

**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†

**Electrical Engineering and Computer Science**: Probability and Random Processes, Signal Processing, Microprocessors, Communication Systems, Digital Signal Processing, Image Processing, Markov Chains, Operating Systems, Information Theory and Coding†, Automatic Speech Processing†, Functional Programming†, Advanced Concentration Inequalities (†*taken at EPFL)*

**Mathematics and Physics**: Calculus, Linear Algebra, Partial Differential Equations, Complex Analysis, Quantum Physics

## Positions of Responsibility

**Student Mentor** *May '23 - Ongoing*

*Student Mentorship Program: Selected based on a rigorous process of interviews, SOP, and peer reviews* *IIT Bombay*

- **Institute Student Mentor:** Responsible for guiding **12 freshmen** through their first year in the institute
- **Department Academic Mentor:** Mentoring a group of **6 junior undergraduates** with their academics and research

**Teaching Assistantships | IIT Bombay**

*Facilitating smooth course organization, grading papers, mentoring students, conducting tutorials and help sessions*

- **Computer Science:** CS 769: Optimization for Machine Learning, CS 768: Learning with Graphs, CS 419: Machine Learning
- **Math and Sciences:** MA 207: Partial Differential Equations, MA 108: Differential Equations, CH 107: Quantum Chemistry

## Extra Curricular Activities and Other Achievements

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| **Achievements** | • Represented IIT Bombay at **Chemenigma** hosted by IISc Bangalore, and stood first overall<br>• Completed all six levels of **Speed Arithmetic** under IPA, and **stood 2nd** in their national-level competition<br>• Winner of the 2020 **Poker** tournament hosted at IIT Bombay |
| **Volunteering** | • Acted as the **Lead Convener** of the Chemistry Club at IIT Bombay promoting the use of **AI in chemistry**<br>• Took **Python** sessions for **1000+** undergraduates and graduates at IIT Bombay over the summer |
| **Others** | • Co-founded **AISRG** – the first student reading group on Artificial Intelligence at IIT Bombay<br>• Elected **Class Representative** for the Electrical Engineering department for three consecutive years<br>• Successfully completed an year-long training in **Chess** under **National Sports Organization** |