Eashan Gupta

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University of Illinois Urbana-Champaign **2023-2027**
Ph.D. in Computer Science *GPA: 3.97/4.0*
Advisor: Prof. Radhika Mittal

University of Illinois Urbana-Champaign **2021-2023**
Master of Science in Computer Science *GPA: 3.97/4.0*

Indian Institute of Technology Bombay **2016-2020**
Bachelors of Technology in Computer Science with Honours *GPA : 9.13/10.0*

Research Interests

I am second-year PhD student at UIUC, advised by Prof. Radhika Mittal. My research interests broadly include Networks and Distributed Systems. I am currently exploring methods to optimize Networks for Machine Learning workloads and collective communication in datacenters.

Publications

- DBO: Fairness for Cloud-Hosted Financial Exchanges [paper]
  Eashan Gupta, Prateesh Goyal, Ilias Marinos, Chenxingyu Zhao, Radhika Mittal, Ranveer Chandra
  ACM SIGCOMM 2023 Conference, New York, NY
- Rethinking Cloud-hosted Financial Exchanges for Response Time Fairness [paper]
  Prateesh Goyal, Ilias Marinos, **Eashan Gupta**, Chaitanya Bandi, Alan Ross, Ranveer Chandra
  ACM HotNets'22: Proceedings of the 21st ACM Workshop on Hot Topics in Networks, Austin, TX
- Upper Bounds for All and Max-gain Policy Iteration Algorithms on Deterministic MDPs [paper]
  R. Goenka, **Eashan Gupta**, S. Khyalia, P. Agarwal, M.S. Wajid, S. Kalyanakrishnan

Research Experience

Collective Tuning as a New Congestion Control Knob for ML workloads **Ongoing**
Guide: Prof. Radhika Mittal | Research project *UIUC*

Working on a system to tune communication collectives like all-reduce dynamically and react to network congestion in shared GPU clusters. Current collective communication mechanisms maintain a static schedule for the long running workloads. Other methods to avoid congested network paths require hardware support, while our solution can be implemented in the software.

Response Time Fairness for Cloud-Hosted Exchanges **May 2022-March 2023**
Internship Guide: Dr. Prateesh Goyal & Dr. Ilias Marinos *Microsoft Research Redmond | UIUC*

Financial exchanges are moving to the cloud from their original on-premises deployments. This raises new network challenges related to fairness and low-latency requirements as cloud is designed to only provide best-effort service at scale. Developed a preliminary solution to ensure fairness for financial exchanges on cloud.

- Designed protocols to host financial exchanges on the cloud and enable response time fairness
- Proved the feasibility of fairness on **Azure** data centres to mitigate inherent latency variations
- Implemented a system prototype of a Fair Cloud-hosted Financial Exchange using **DPDK**, operating at a high transaction rate of $125k$ trades per second with sub-100μs end-to-end p999 latency and

Improving upper bounds of Policy Iteration Algorithm in RL **Feb-June 2020**
Guide: Prof. Shivaram Kalyanakrishnan *IIT Bombay*

- Proved exponentially better upper bounds for number of steps taken by Policy Iteration Algorithm (**PI**) in deterministic Markov Decision Processes by counting tadpole subgraphs
- Partially resolved a conjecture about Howard's PI taking at most order Fibonacci steps on 2-action MDPs by establishing upper bounds for DMDPs

Towards validation of RTL passes of the GCC compiler **Jan-June 2020**
Guides: Prof. Amitabha Sanyal & Prof. Supratik Chakraborty *IIT Bombay*

- Analysed the various Register Transfer Language (**RTL**) optimization passes in **GCC-4.7.2** and implemented a **block-by-block** validation technique to validate program transformations done by the passes
- Realized obligations based on the return values, heap memory and function calls of programs in the **Z3 Theorem Prover** tool to prove semantic equivalence between different control flow graphs (**CFGs**)
- Studied the internal workings of GCC-4.7.2 compiler and developed various plugin tools for analysis

Professional Experience

Nutanix Technologies, Bangalore **July 2020-July 2021**
Nutanix is the leading Enterprise Cloud provider based in San Jose, California

- Software developer at Nutanix in the teams Microservices Platform and Karbon (**MSP/Karbon**)
- Used **Kubernetes** to deploy microservices on a Hyper-converged Infrastructure using virtual machines
- Worked to support the Karbon platform on **VMware's hypervisor ESX** other than AHV (in-house)
- Added multiple features to the Karbon controller like migration to **CoreDNS** on k8s upgrade; network segmentation for efficient traffic handling; redacting logs; tracking metrics using **Prometheus** and middlewares
- Managed a new version release including testing and publishing to production; Handled Customer Oncalls

Core Engineering Team, Tower Research Capital, Gurugram **May-July 2019**
Automation of Timing Performance Checks *Summer Internship*

- Automated the performance **testing platform** for the software processing the order book data broadcast
- Experimented over various environments using different configurations of **cache allocation technology** and running processes in parallel to observe performance statistics and any dependency patterns

Awards and Scholastic Achievements

- Secured **All India Rank 38** in **IIT JEE Advanced** among 200 thousand candidates (2016)
- Secured **All India Rank 122** in **IIT JEE Mains** among 1.2 million candidates (2016)
- Received Gold medal for being in the **top 35** students in **Indian National Physics Olympiad** (2016)
- Amongst the **top 30** students selected to attend Orientation cum Selection Camp of **INAO**, Indian National Astronomy Olympiad (2016)
- Recipient of **Kishore Vaigyanik Protsahan Yojna Fellowship** (KVPY) with an **All India Rank** of **121**, instituted by the Department of Science and Technology, Government of India (2015)
- Recipient of **National Talent Search Examination** Scholarship awarded by the Govt. of India (2014)
- Amongst the **top 1%** students in **NSEC**, National Standard Examination in Chemistry (2016)

Coursework

- **Relevant Courses (IIT Bombay):** Graph Theory, Functional Programming Languages, Advances in Intelligent and Learning Agents, AI and Machine Learning, Web Search and Information Retrieval, Digital Image Processing, Computer Graphics
- **Relevant Courses (UIUC):** Advanced Computer Networks, High-speed & Programmable Networks, Advanced Operating Systems, Advanced Distributed Systems, Applied Parallel Programming, Computer Security, ML for Signal Processing, Efficient & Predictive Vision, Knowledge-driven Natural Language Generation

Teaching & Mentoring Experience

- **Graduate Teaching Assistant** -
  - CS 425 (Spring'23) - Distributed Systems with Prof. Radhika Mittal at UIUC
  - CS 441 (Coursera) (Fall'21, Spring'22, Fall'22) - Applied Machine Learning with Prof. Marco Morales
- **Undergraduate Teaching Assistant** - Selected to manage a class of 100 first-year students for the basic undergraduate course of CS101. Coordinated with the Computer Science Department to conduct regular lab sessions and evaluate exam papers
- **Teaching Assistant** - Managed the forum for the online course Soft Skills on the online platform IITBombayX MOOC. Tasked to create questions and such material for the same course.

Notable Projects

Reduction in Games played on recursion schemes **May-July 2018**
Guide: Prof. Roland Meyer | Summer Internship *TU Braunschweig, Germany*

- Worked on the reduction of parity games to safety games played on higher order recursion schemes (**HORS**), using similar results on reduction in games played on collapsible pushdown automata (**CPDA**)
- Studied equivalence between HORS and CPDA using **Krivine machines** and λ-labelled deterministic digraph
- Worked to improve lower bound on the number of counters used in reduction from parity to safety games

Optimized DL GPU Task Scheduling for NVIDIA Jetson TX2 [GitHub] — **Aug-Dec 2021**
Guide: Prof. Tianyin Xu | Course Project *University of Illinois Urbana-Champaign*

- Showed that the Nimble algorithm in **PyTorch** is hardware dependent and is not always successful in improving GPU performance by experiments on the Jetson TX2, a popular embedded AI systems hardware
- Implemented GPU task scheduling algorithms for deep learning inference models based on greedy longest chains and load balancing in PyTorch and improved **performance** on certain models by upto 16% on TX2

Implementation of Abstract Domains for Program Verification **Jan-May 2019**
Guide: Prof. Supratik Chakraborty | Research Project *IIT Bombay*

- Studied abstract interpretation of program verification using domain specific techniques and fixed point analysis
- Implemented **congruence** and **array** abstract domains in **C++** for integration into the **CAnalyzer** tool
- Engineered the array abstract domain by mapping segments of an array to their abstract values; bounds of the values stored as variable expressions which are used in **context-free** comparisons to complete operations

NLNet: Configuring Networks with Natural Language **Jan-May 2022**
Guides: Prof. Matthew Caesar, Prof. Heng Ji | Course Project *University of Illinois Urbana-Champaign*

- Developed methods to convert high level invariants in natural language to appropriate network function calls to configure a network
- Used AMR parsing to model a classification task based on the network API documentation and improved accuracy using feedback from network verification rules

Team Member, ADCS, Advitiy **Feb-Dec 2017**
Advitiy is the 2^{nd} student satellite of IITB, technically advanced and efficient version of the 1^{st}, Pratham

- Developed a simulation for a simple Feedback Control System for a motor in **MATLAB** and **Simulink** based on the **PID controller** to understand the control law currently employed in Pratham
- Performed **battery simulations** for the satellite in MATLAB to analyze its charging and discharging cycles to validate the control law employed in Pratham and check overall functioning of the satellite

Othello AI **Jan-April 2017**
Guide: Prof. Amitabha Sanyal | Course Project *IIT Bombay*

- Developed the single player mode for the game of Othello in **Racket**, a multi-paradigm programming language, using concepts of **dynamic weights** and **functional programming**
- Determined a winning probability of 0.88 of our single player algorithm against natural greedy algorithm

Extracurriculars

- Attended **Vijyoshi camp** conducted by IISER, Kolkata which serves as a forum for interactions between bright young students and leading researchers and promotes research among them
- Successfully completed one year training in **lawn tennis** under **NSO**, IIT Bombay
- Stood **first** in the inter-school **stone painting** competition
- Among top 5 teams in XLR8 competition, building a bluetooth controlled bot during freshman year