Avaljot Singh

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Research Interest

I am interested in working on Formal Methods and Programming Language. My current research is focused on designing ConstraintFlow, a DSL for Neural Network Certifiers. The high-level declarative specification in ConstraintFlow can be automatically verified for soundness and compiled into optimized executables. Additionally, I am keen to explore the application of large language models (LLMs) in program analysis.

Education

University of Illinois Urbana-Champaign
PhD in Computer Science; GPA: 4.0/4.0 — *Aug 2022 - Present*
Advisors: Prof. Gagandeep Singh, Prof. Charith Mendis
Research Areas: Programming Languages and Formal Methods

Indian Institute of Technology, Delhi
Bachelors & Masters in Computer Science; GPA: 9.5/10 — *July 2016 - May 2021*
Advisor: Prof. Sanjiva Prasad
Thesis: Algebraic techniques for network routing

Awards

ConstraintFlow: A Declarative DSL for Certified Artificial Intelligence — **SRC @ PLDI'24**
Avaljot Singh — *Bronze Medal*

Interpreting Robustness Proofs of Deep Neural Networks — **WFVML @ ICML'23**
Debangshu Banerjee, ***Avaljot Singh****, Gagandeep Singh* — *Outstanding Paper*

Publications

A Tensor-Based Compiler and a Runtime for Neuron-Level DNN Certifier Specifications [In Submission]
Avaljot Singh*, Yasmin Sarita, Aditya Mishra, Ishaan Goyal, Gagandeep Singh, Charith Mendis* — *Arxiv*

Synergistic Synthesis of Ranking Function and Invariants for Termination Analysis [In Submission]
Yasmin Sarita, ***Avaljot Singh****, Shaurya Gomber, Gagandeep Singh, Mahesh Viswanathan* — *Arxiv*

Safety and Trust in Artificial Intelligence with Abstract Interpretation
Foundations and Trends in Programming Languages, 2025
Gagandeep Singh, Jacob Laurel, Sasa Misailovic, Debangshu Banerjee,
Avaljot Singh*, Changming Xu, Shubham Ugare, Huan Zhang* — *Journal*

Automated Verification of Soundness of DNN Certifiers — **OOPSLA'25**
Avaljot Singh*, Yasmin Sarita, Charith Mendis, Gagandeep Singh* — *Paper*

ConstraintFlow: A DSL for Specification and Verification of Neural Network Analyses — **SAS'24**
Avaljot Singh*, Yasmin Sarita, Charith Mendis, Gagandeep Singh* — *Paper*

Interpreting Robustness Proofs of Deep Neural Networks — **ICLR'24**
Debangshu Banerjee, ***Avaljot Singh****, Gagandeep Singh* — *Paper*

Work Experience

Graviton Research Capital LLP — Gurugram, India
Quantitative Researcher — *June 2021 – July 2022*

- Developed NSE options' arb-strategy

- Worked on parameter fittings for quantitative strategies using different algorithms

Uber [Remote] Hyderabad, India
Intern *May 2020 – July 2019*

- Information extraction from documents using **text detection, recognition, and classification**
- Used state-of-the-art deep learning techniques for text detection and recognition using **CRAFT model**
- Novel way of text classification using **graph isomorphisms** by detecting textual features

Research Internships

Symbolic Information Guided Reliability of LLM Agents May 2025 - August 2025
Shraddha Barke, Suman Nath, Microsoft Research *Redmond, USA*

- Studies the failure analysis for LLM agents
- Designed symbolic ways to improve their reliability

M4L: Mixed-mode MPC for Machine Learning March, 2021 - June, 2021
Rahul Sharma, Microsoft Research *Bangaluru, India*

- Designed DSL and a type system for **Mixed-mode MPC**
- Proved the **formal guarantees** of correctness and cryptographic security for well-typed programs

Algebraic techniques for network routing [Masters Thesis] January 2020 - December 2020
Prof. Sanjiva Prasad, IIT Delhi *Delhi, India*

- Conservatively extended NetKAT to **Cost-InterNetKAT** involving three distinct innovations
- Introduced inter-layer routing and cost algebra, thus allowing composition of cost-dependent NetKAT policies
- Designed Cost-InterNetKAT **homomorphisms, refinements, absratractions and translations**

Synthesis and Unified Management of Hybrid Networks May, 2019 - July, 2019
Prof. Nate Foster, Cornell University *Ithaca, USA*

- Defined the syntax and semantics of **Edge-NetKAT**
- Pushing the functionality of NetKAT programs to configurable edge devices.

Object Detection for Local Spotting using 2DOF Actuator June, 2018 - July, 2018
Prof. Idaku Ishii, Hiroshima University *Hiroshima, Japan*

- Implemented a facial recognition system mounted on **mechanical tracking system** for security cameras
- Used **High speed Camera Interfacing** for real-time image synthesis and real-time tracking system

Teaching Experience

CS477 Formal Software Development Methods, UIUC	Spring'24
Analysis and Design of Algorithms, IIT Delhi	Spring'21
Introduction to Functional Programming, IIT Delhi	Fall'20
Programming Languages, IIT Delhi	Spring'20
Introduction to Computer Science, IIT Delhi	Fall'19

Academic Service

- **Reviewer:** Formal Methods in System Design, 2024

Scholastic Achievements

- **2021:** IIT Delhi Semester Merit Award for department **Top 7%** for 7 semesters
- **2020:** Attended 25th Estonian Winter School in Computer Science
- **2016:** **All India Rank 141** in IIT Joint Entrance Examination (Advanced)
- **2016:** Stood among National **Top 1%** in National Standard Examination in Chemistry (NSEC)
- **2016:** Stood among National **Top 1%** in National Standard Examination in Astronomy (NSEA)
- **2015:** Selected as Kishore Vaigyanik Protsahan Yojana (**KVPY**) Fellow by IISc Bangalore
- **2013:** Selected as National Talent Search Examination (**NTSE**) Scholar by CBSE Delhi