

Shaurya Gomber

(+1) 217-979-5106 | sgomber.github.io | sgomber31@gmail.com | linkedin.com/in/sgomber | github.com/sgomber

EDUCATION

University of Illinois Urbana-Champaign

Masters of Science (thesis-track), Computer Science; GPA: 4.0/4.0

Specialization: Formal Methods and Programming Languages

Proposed Thesis Title: Neural Abstract Transformers for Efficient Program Verification

Illinois, USA

Aug 2022 - May 2024

Indian Institute of Technology Guwahati

B. Tech, Computer Science and Engineering; GPA: 9.66/10 (Insti. Rank: 3)

Thesis Title: Readability Analysis of Scientific Writing

Assam, India

July 2016 - June 2020

PUBLICATIONS

S=IN SUBMISSION, PS= PLANNED SUBMISSION

[S.1] Synergistic Synthesis of Ranking Function and Invariants for Termination Analysis **PLDI '24**

Yasmin Sarita, Avaljot Singh, Shaurya Gomber, Mahesh Viswanathan, Gagandeep Singh

[In Submission]

[PS.1] Enabling Type-Cast Operations in SMT with Efficient Oracle Encodings **CAV '24**

Shaurya Gomber, Kevin Cheang, Dejan Jovanovic, Andrew Reynolds, Amit Goel

[Planned for Submission]

RESEARCH EXPERIENCE

Learning Efficient Neural Abstract Transformers

Prof. Gagandeep Singh, Dept. of Computer Science, UIUC

Mar 2023 - Present

Champaign, IL, USA

- Abstract Transformers (used in static analysis) can be computationally expensive (like join in polyhedra domain).
- Exploring ways to *train neural networks to emulate these transformers* while ensuring soundness and precision in the training process. These neural transformers can replace the expensive transformers to speed up verification.
- Soundness is a logical constraint and can be validated using off-the-shelf SMT Solvers. We are using neuro-symbolic techniques like [Differentiable Logical Loss](#) and modified versions of Projected Gradient Descent (PGD) to integrate logical soundness constraints and non-differentiable outputs from SMT solvers into the training phase.

Automated Termination Analysis of Loop Programs

Prof. Gagandeep Singh and Prof. Mahesh Viswanathan, Dept. of Computer Science, UIUC

Aug 2023 - Nov 2023

Champaign, IL, USA

- Proving termination by finding ranking functions and loop invariants is challenging due to large search spaces.
- Recognizing that not all invariants are suited to validate ranking functions, we develop a framework that *synergistically synthesizes ranking functions and invariants* with a shared goal of proving program termination.
- Our approach handles general programs with complicated syntax (non-linear assignments, disjunctive boolean guards) and provides relative completeness guarantees.
- We demonstrate termination of *10% more cases* from standard termination benchmarks in SV-COMP compared to current state-of-the-art methods. We have submitted this work for review at *PLDI '24*.

Encoding Type-Casting Semantics in SMTO

Kevin Cheang, Dejan Jovanovic, Andrew Reynolds, Automated Reasoning Group, AWS

May 2023 - Aug 2023

Santa Clara, CA, USA

- Worked as an Applied Science Intern on the tool [Zelkova](#).
- Zelkova reasons about AWS access control policies by encoding them and verification conditions as SMT queries.
- However, some semantics can be hard to encode in SMT, like conditions that rely on type-casting. For e.g.: allow access if a string S in the request context is numerically less than 42.
- We developed efficient encodings using [SMTO](#) (SMT with Oracles) to encode such *type-casting semantics*.
- This *solved ~ 30k such production queries* (unsolved before) with avg. query solving time *1 min*.
- Also *contributed to CVC5's SMTO solver* by identifying/fixing bugs and improving the oracles I/O interface.
- Filed a patent for our encodings. Also working on a paper that we plan to submit to *CAV '24*.

Inductive Syntax-Guided Synthesis

Prof. Madhusudan Parthasarathy, Dept. of Computer Science, UIUC

Nov 2022 - Feb 2023

Champaign, IL, USA

- Devised optimal techniques to solve syntax-guided synthesis (SyGuS) problems inductively using solvers like Z3.
- Explored ways in which the search space of possible programs can be effectively pruned by analyzing the input-output examples that do not satisfy a guessed/computed candidate program.

Readability Analysis of Scientific Writing

Aug 2019 - May 2020

Prof. Ashish Anand, Dept. of Computer Science, IIT Guwahati

Guwahati, India

- As part of my [Bachelors Thesis](#), I developed the tool [VReadA](#) ([Visual Readability Analyzer](#)), which generates a visual heatmap analysis of the readability of a text sample by analyzing various readability metrics.
- It analyzes the *linguistic complexity, predictability, perplexity, and coherence* among sections of the sample.
- It uses novel coherence calculation methods and state-of-the-art Language Models to achieve high accuracy.

INDUSTRY EXPERIENCE

Software Engineer II

June 2020 – June 2022

D.E. Shaw & Co.

Hyderabad, India

- **Low latency distributed system:** Worked on the firm's proprietary electronic trading system: a distributed application engineered to efficiently handle large amounts of trading data (in TBs) flowing throughout the day.
- **Full Stack Development:** Worked on the full stack development of enhancements to the trading system. This included features to optimize the traders' workflows like giving them the flexibility to define new data in the UI from existing data by specifying any arbitrary computations.
- **Code reviews and design discussions:** Did code reviews of some major projects and participated in design discussions for various components of the trading system.
- **Mentored new joiners:** I was responsible for mentoring and guiding two new SDE-1s that joined our team.
- **Tech Stack:** Java & C++ (backend), React (frontend). Misc: Git, Python, Bash, Grafana, Numpy, Matplotlib.

Software Engineering Intern

May 2019 – July 2019

D.E. Shaw & Co.

Hyderabad, India

- Implemented a *type-safe low-latency API* in Java to read and write trading data on the on-premise database.
- Used it to get 60x run-time improvement in production-critical scripts (Got a Pre-Placement Offer for my work).

TEACHING EXPERIENCE

Teaching Assistant, CS421 Programming Languages & Compilers [↗](#) Jan – May '23, Aug – Dec '23

Prof. Elsa Gunter, University of Illinois Urbana-Champaign

Champaign, IL, USA

- As TA for CS421 in Spring 2023 and Fall 2023, I conducted office hours to assist students with questions and assignments related to course topics like functional programming, type theory, lexing, parsing, and Hoare logic.
- Other responsibilities include making assignments and exams and proctoring exams.

Teaching Assistant, CS225 Data Structures & Algorithms [↗](#)

Aug 2022 – Dec 2022

Prof. Carl Evans & Prof. Brad Solomon, University of Illinois Urbana-Champaign

Champaign, IL, USA

- As TA for CS225 in Fall 2022, I conducted office hours to assist students with questions and assignments related to course topics, including linked lists, trees, graphs, and graph algorithms.
- Other responsibilities include making assignments and exams and proctoring exams, conducting weekly lab sessions, and grading the final projects.
- Received [positive feedback](#) on my lab sessions from the students.

Placement Lectures Coordinator

Aug 2019 – Nov 2019

IIT Guwahati

Guwahati, India

- Taught Data Structures & Algorithms to 100+ candidates appearing for placements.
- I was also responsible for scheduling the lectures and deciding the content of the lectures. The lectures covered all the important data structures like Linked Lists, Binary Search Trees, Graphs, etc.
- This contributed to students securing positions in top companies such as Google, Uber, Microsoft, etc.

TALKS

Verification & Certified Training of PINNs

CS598 Scientific Machine Learning, Fall 2023, UIUC

Nov 2023

[Slides](#)

Satisfiability and Synthesis Modulo Oracles

Formal Methods Seminar, Fall 2023, UIUC

Nov 2023

[Slides](#)

Neural Approximations of Abstract Transformers

CS477 Formal Software Development Methods, Spring 2023, UIUC

May 2023

[Slides](#)

Synthesizing Abstract Transformers

Formal Methods Seminar, Spring 2023, UIUC

Mar 2023

[Slides](#)

Monotonic Neural Networks

CS521 Trustworthy AI Systems, Fall 2022, UIUC

Nov 2022

[Slides](#)

SELECTED PROJECTS

Verification and Certified Training of PINNs | *Python, Tensorflow, Numpy* | [Code](#) Oct 2023 – Nov 2023

- PINNs (Physics-Informed Neural Networks) are neural network architectures designed to solve partial differential equations by embedding the governing equations as constraints during training, with the residual error representing the discrepancy between predicted and true solutions.
- Computed worst-case residual error bounds of PINNs using methods such as Interval Bounds Propagation (IBP).
- Used Projected Gradient Descent (PGD) and Certified Training (using the worst-case residual bounds computed above) to re-train the PINNs.
- Demonstrated that the PINNs trained using PGD and Certified training methods have provably lower worst-case residual error bounds and thus learn better models than vanilla training.

Monotonic Neural Networks | *Python, Keras, Tensorflow, Numpy* | [Code](#) Oct 2022 – Nov 2022

- Monotonic Neural Networks are ones whose outputs vary monotonically with respect to the input features.
- Implemented a gradients-based loss method that enforces monotonicity while training neural networks.
- Demonstrated its effectiveness on networks that predict house rents (monotonically increasing with number of rooms) and life expectancy (monotonically decreasing with the cholesterol levels).

Efficient SAT Solver | *Python* | [Code](#) Mar 2020 – May 2020

- Implemented the *CDCL (Conflict Driven Clause Learning)* SAT algorithm, with state-of-the-art optimizations like 2-watched literals, Decision Heuristics (VSIDS, DLIS) and Restart Heuristics (Geometric, Luby).
- Devised new heuristics based on intelligent data structures (Priority Queues) and innovative restart strategies.

Traffic Light Model Checker | *NuSMV Model Checker* | [Code](#) Oct 2019 – Nov 2019

- Used the [NuSMV Model Checker](#) to simulate the traffic lights model at a road junction.
- Verified its correctness by checking temporal-logic safety constraints in Linear Temporal Logic (LTL) like two lights can not be on simultaneously.

Compiler Construction | *C++, Flex, Bison, SPIM simulator* | [Code](#) Jan 2019 – Apr 2019

- Developed a *compiler for a C-like language* from scratch by implementing all stages of compilation.
- The stages include: lexical analysis, parsing, intermediate code generation, and target MIPS code generation.
- It supported: Function calls, expressions (relational, arithmetic and logical), if-else, switch, for and while loops.

RELEVANT COURSEWORK

- **Formal Methods & PL:** Formal Methods for System Verification, Basics of Automated Reasoning, Program Verification, Trustworthy AI Systems, Formal Software Development Methods, Formal Languages and Automata Theory, Theory of Computation, Compilers (with lab)
- **Mathematics:** Discrete Mathematics, Linear Algebra, Real Analysis, Multi-variate calculus, Introduction to Differential Equations, Convex Optimization, Probability Theory and Random Processes
- **Misc. Computer Science:** Operating Systems (with lab), Networks (with lab), Algorithms, Databases (with lab), Computer Architecture, Digital Design, Parallel Computer Architecture, Computer Vision, Applied Machine Learning, Scientific Machine Learning

MENTORSHIP & SERVICE

- **National Service Scheme (NSS) IITG:** As a volunteer for [NSS IIT Guwahati](#), events, I taught mathematics to local high school students and also participated in education awareness campaigns.
- **Mentored CSE freshers** under the Mentor-Mentee program of the [SAATHI Counselling Club](#) of IIT Guwahati.
- **Placement Lectures Coordinator, IITG (Fall 2019):** Organized the lectures (content, schedule etc.) and taught Data Structures & Algorithms to the candidates appearing for placements.
- **Treasurer, CSEA (2019-20):** Served as the treasurer of Computer Science and Engineering Association, IIT Guwahati and was responsible for the fund management and allocation for the CSEA events.
- **Captain, Freshers' Lawn Tennis Tournament 2016:** Captained my team to **first** position in the tournament.
- **Cultural Panel, Umiam Hostel 2017:** Was responsible for script writing and preparing the freshers for drama and mime competitions.

ACHIEVEMENTS

- **Institute Merit Scholarship IITG 2019:** Awarded a scholarship worth \$2900 (equivalent to a one-year tuition fee) for scoring the highest grades in the academic year 2018-19.
- **Microsoft Code.Fun.Do 2019:** Our team was among the *top 10* national finalists from 300+ teams participating nationwide in a hackathon on designing a Blockchain-based Voting System.
- **Inter IIT Tech Meet 2018:** Represented IIT Guwahati in coding hackathon event (Ranked 5th out of 25 teams).
- **ACM ICPC 2018:** Represented IIT Guwahati in India regionals held at Amritapuri, Kerala.
- **Sawaal, the question-paper sharing app:** Developed and launched a student-focused app at IITG for easy storage, sharing, and retrieval of previous year question papers. The app has become the go-to solution for accessing past papers, streamlining the process for students.
- **Inter-hostel Technical Competition 2017, 2018:** Won gold medals for my hostel in the full stack hackathon events at the inter-hostel technical competitions of the year 2017 and 2018.
- **Kishore Vaigyanik Protsahan Yojana (KVPY) 2015:** Secured All India Rank *178 out of 1.5 million* candidates in this Science Aptitude examination conducted by IISc, Bangalore.
- **IIT JEE Mains 2016:** Secured All India Rank *2323 out of 1.5 million* candidates in the preliminary phase of Joint Entrance Examination for engineering in India.
- **IIT JEE Advanced 2016:** Secured All India Rank *902 out of 1.5 million* candidates in the advanced phase of Joint Entrance Examination for engineering in India.