

# Hari Govind V K

PHD CANDIDATE AT THE UNIVERSITY OF WATERLOO

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## Research

### Software Model Checking

Z3, SMT, CONSTRAINT SOLVING, CONSTRAINED HORN CLAUSES

- My primary research interest is in enabling scalable and fully automatic formal verification. So far, I have been focusing on *model checking* using Constrained Horn Clauses (CHC).
- Many of my research projects have been implemented on top of [Spacer](#): a model checking engine used to discharge software verification and theorem-proving queries.
- Spacer is part of Z3: an open source automated theorem prover framework in C++. [My fork](#)

### Equality and Uninterpreted Functions

July 21 - Present

- CHC solvers rely on SMT solvers to interpret all basic operations like addition and multiplication. However, expensive and unnecessary SMT queries slow down CHC solvers.
- Working on a CHC solver that uses Equality and Uninterpreted Functions (EUF) to abstract all theory operations.
- As a step in this direction, we implemented a quantifier elimination algorithm for a combination of theories centralized around an EUF core.
- We also implemented a new modular SAT-solving technique. This will be used at the heart of our new model checker.
- Publications: [Vediramana Krishnan H.G.](#), Garcia-Contreras I, Shoham S., Gurfinkel A. "Speculative SAT modulo SAT". In: TACAS (2024). Garcia-Contreras I\*, [Vediramana Krishnan H.G.\\*](#), Shoham S., Gurfinkel A. "Fast Approximations of Quantifier Elimination". In: Computer Aided Verification (2023). (\* indicates equal contribution)

### Coherent Uninterpreted Programs

March 21 - May 21

- Uninterpreted programs (UP) are interesting from a theoretical point of view because they are simple yet their verification is undecidable. Recently, Coherent UP have been identified as a subclass of UP whose verification is decidable.
- We give a logical characterization for Coherent UP and show that all Coherent programs are bisimilar to finite state systems
- Publication: [Vediramana Krishnan H.G.](#), Shoham S., Gurfinkel A. "Logical Characterization of Coherent Uninterpreted Programs". In: Formal Methods in Computer Aided Design (2021).

### Recursive Data Types and Recursive Functions

September 20 - July 21

- Recursive data types (list, trees) appear frequently in programs. They are often coupled with recursive functions (list length, tree height). The undecidability of reasoning about recursive functions makes automatic verification very challenging for programs that manipulate recursive data types.
- Developed a new procedure that both, abstracts recursive functions and translates them to CHCs, in order to tackle undecidability.
- Publication: [Vediramana Krishnan H.G.](#), Shoham S., Gurfinkel A. "Solving Constrained Horn Clauses Modulo Algebraic Data Types and Recursive Functions". In: Principles of Programming Languages (2022).

### Global Guidance

February 19 - January 20

- A constant source of frustration in using Spacer is its instability: apparently trivial changes to the input can have adverse effect on Spacer's performance. Part of the reason is that Spacer is very tightly coupled to the underlying SMT solver.
- Introduced a new technique (Global guidance) to course correct Spacer if it starts to diverge because the underlying SMT solver returned suboptimal proofs.
- Publication: [Vediramana Krishnan H.G.](#), Chen Y., Shoham S., Gurfinkel A. "Global Guidance for Local Generalization in Model Checking". In: Computer Aided Verification (2020).
- Extended the technique to word level model checking
- Publication: [Vediramana Krishnan H.G.](#), Fedyukovich G., Gurfinkel A. "Word Level Property Directed Reachability". In: International Conference in Computer Aided Design (2020).

### Hardware Model Checking

C++, PYTHON, BASH

May 18 - February 19

- Worked on [Apy](#): an open source model checking tool for verifying functional correctness of digital circuits.
- Designed and implemented a new algorithm that uses the principle of k-induction to guide generalizations during search.
- Made an exponential speed up on a class of benchmark instances.
- Publications: [Vediramana Krishnan H.G.](#), Vizek Y., Ganesh V., Gurfinkel A. "Interpolating Strong Induction". In: Computer Aided Verification (2019). [Vediramana Krishnan H.G.](#) "Strong Induction in Hardware Model Checking". Master's thesis.

## Education

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### PhD in Electrical And Computer Engineering

UNIVERSITY OF WATERLOO

Ontario, Canada

September 2019 - Present

- Supervisor: Prof. [Arie Gurfinkel](#).
- Relevant courses: Programming Languages Foundations in Agda, Introduction to Symbolic Computation

### MASc in Electrical And Computer Engineering

UNIVERSITY OF WATERLOO

Ontario, Canada

September 2017 - August 2019

- Supervisors: Prof. [Arie Gurfinkel](#) and Prof. [Vijay Ganesh](#).
- Relevant courses: Automated Program Verification, Computer-aided Reasoning, Convex Optimization.
- GPA: 91%.

### B.Tech in Electronics and Communication Engineering

COLLEGE OF ENGINEERING THIRUVANANTHAPURAM

Thiruvananthapuram, India

June 2012 - July 2016

- GPA: 84%.

## Awards

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### Distinguished Paper Award at CAV 23

[HTTP://WWW.I-CAV.ORG/2023/ACCEPTED-PAPERS/](http://www.i-cav.org/2023/accepted-papers/)

Paris, France

2023

- The paper was invited to be published in the special issue of Formal Methods in System Design journal.

### 2021-2022 Microsoft Research PhD Fellow

[HTTPS://WWW.MICROSOFT.COM/EN-US/RESEARCH/ACADEMIC-PROGRAM/PHD-FELLOWSHIP/](https://www.microsoft.com/en-us/research/academic-program/phd-fellowship/)

Virtual

2021

- One of 45 students from all over the world to receive this award.

### Winner of CHC Comp

[HTTPS://CHC-COMP.GITHUB.IO/](https://chc-comp.github.io/)

Virtual

2020 and 2021

- CHC Comp is an annual competition to compare state-of-the-art CHC solvers.
- Our tool, Spacer, won all tracks in the 2021 CHC Competition and all but one track in the 2020 competition

### Faculty of Engineers Award (FOE)

PRESENTED BY ECE DEPARTMENT, UNIVERSITY OF WATERLOO

Waterloo, Canada

Winter 2020

- Merit driven scholarship based on comparing accomplishments of peer researchers in the department.
- One among 24 students to receive this award.

## Professional Experience

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### Research Intern at Microsoft Research

PL: LLMs, RUST

Bangalore, India

January 24 - ongoing

- Rust programs are more memory safe than C programs
- Exploring the use of LLMs to translate C programs into idiomatic Rust programs

### Research Intern at MathWorks

PL: SIMULINK, OCAML

Boston, USA

Aug - Nov 23, May - Aug 22, July - Aug 21

- Worked on verifying Simulink models using Simulink Design Verifier (sldv)
- Encoded Simulink models as Constrained Horn Clauses
- Tested efficiency of CHC solver Spacer as a backend for sldv

### Teaching Assistant

PL: PYTHON, CPP, DAFNY

Waterloo, Canada

Jan. 2018 - Present

- Handled 6 undergraduate courses and 2 graduate courses
- Gave tutorials for a data structures and algorithms course.
- Handled theory and lab sections of a compilers course.
- Responsible for setting up and grading assignments and exams.

## Service

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Proceedings chair for CAV'22, CAV'24, Organizer for CHC-COMP'22 and 23, Artifact Evaluation Committee member TACAS'23 and VMCAI'21