Robert Lorch

Curriculum Vitae

Education

Present **Ph.D. (Computer Science)**, *The University of Iowa*, *GPA – 4.25*.

2022 **M.C.S.**, *The University of Iowa*, *GPA – 4.33*.

2021 **B.A. (Computer Science)**, *Grinnell College*, *GPA – 3.94, Major GPA – 4.00*.

Professional Appointments

2022–Present **Research Assistant**, *The University of Iowa*, Iowa City, IA.

- I contribute to KIND 2, which is a multi-engine SMT-based model checker for safety properties of infinite-state synchronous reactive systems expressed as an extension of the Lustre language. Below are some of the features I've implemented.
- *Feature 1:* Refinement types (predicate subtypes)
- *Feature 2:* Polymorphic nodes, functions, and contracts
- *Feature 3:* A nondeterministic choice operator that outputs an element of a given type satisfying a given predicate
- *Feature 4:* Imperative-style `if` blocks with dedicated syntax for frame conditions
- *Feature 5:* Open intervals for integer subrange types

2024–2025 **Applied Scientist Intern**, *Amazon Web Services*, Portland, OR.

- *Project 1:* Contributed to SMT-D, Amazon's parallel SMT solver. My work diagnosed performance regressions, explored new ideas in parallel SMT (e.g., clause sharing heuristics), and prepared SMT-D for open source release.
- *Project 2:* Designed an SMT query-response caching architecture, implemented a prototype, and evaluated on internal data. The architecture addresses latency, robustness, brittleness, and soundness concerns associated with cloud-scale SMT solving.

2023–2024 **Fellow Intern**, *GE Global Research*, Niskayuna, NY.

- *Project 1:* Designed a formal requirements capture tool using LLMs to translate natural language requirements to statements in formal logic.
- *Project 2:* Developed a requirements capture DSL called TRACE (Toolkit for Requirements Analysis, Capture, and Elicitation), using formal methods techniques to automatically detect flaws in the requirements.
- *Project 3:* Formally modeled an automated vaccine production system in Cyber Resiliency Verifier to discover architectural and behavioral cyber vulnerabilities. Used this information to inform the further design and development of the system.
- *Project 4:* Formally modeled an abstract specification of a handshake protocol for use within a zero-knowledge proof workflow.

2021 **Software Engineer Intern**, *Principal Financial Group*, Des Moines, IA.

- Used Amazon Web Services infrastructure to store and process clients' financial data.
- Designed and implemented a website to market technology at Principal to potential employees, winning an award at the intern code jam.

14 MacLean Hall – Iowa City, IA 52242
+1 (765) 212 4787 • *robert-lorch@uiowa.edu*
lorchrob.github.io

2020–2021 **Immersive Experiences Lab**, *Grinnell College*, Grinnell, IA.
- Designed and implemented an interactive virtual reality experience using Unity and C# to assist in the teaching of linear transformations.

2020 **Graph Theory REU**, *Moravian University*, Bethlehem, PA.
- Proved new theorems about the strong proper connection number of various graph classes, leading to a research paper.

2019 **Applied Math REU**, *IUPUI*, Indianapolis, IN.
- Designed and implemented a mathematical cancer cell model using MATLAB in order to learn about cancer cell movement through the bloodstream.

Publications

2025 D. Dar, **R. Lorch**, A. Sadeghi, V. Sorcigli, H. Gollier, C. Tinelli, M. Vanhoef, and O. Chowdhury, "SAECRED: A State-Aware, Over-the-Air Protocol Testing Approach for Discovering Parsing Bugs in SAE Handshake Implementations of COTS Wi-Fi Access Points," **S&P** '25.

2025 B. Meng, S. Varanasi, **R. Lorch**, A. Moitra, K. Siu, S. Paul, M. Durling, N. Beniwal and N. Visnevski, "TRACE: Toolkit for Requirements Analysis Capture and Elicitation," **NFM** '25.

2024 **R. Lorch**, D. Larraz, C. Tinelli, O. Chowdhury, "A Comprehensive, Automated Security Analysis of the Uptane Automotive Over-the-Air Update Framework," **RAID** '24. `https://dl.acm.org/doi/pdf/10.1145/3678890.3678927`

2024 **R. Lorch**, B. Meng, K. Siu, A. Moitra, M. Durling, S. Paul, S. Varanasi, "Formal Methods in Requirements Engineering: Survey and Future Directions," **FormaliSE** (colocated with ICSE) '24.
`https://lorchrob.github.io/publications/re_survey_paper.pdf`

2023 D. Larraz, **R. Lorch**, M. Yahyazadeh, F. Arif, O. Chowdhury, and C. Tinelli, "CRV: An automated resiliency reasoner for system design models," **FMCAD** '23.
`https://daniel-larraz.github.io/papers/fmcad23.pdf`

2022 B. Carrigan, D. Diaz, J. Hammer, J. Lorch, and **R. Lorch**, "Constructing $(3, b)$-sudoku pair Latin squares," **Australasian Journal of Combinatorics** '22.
`https://ajc.maths.uq.edu.au/pdf/82/ajc_v82_p031.pdf`

2021 B. Carrigan, J. Hammer, J. Lorch, **R. Lorch**, and C. Owens, "List colorings count rokudoku-pair squares," **Bulletin of the Institute of Combinatorics and its Applications** '21. `http://bica.the-ica.org/Volumes/92//Reprints/BICA2020-34-Reprint.pdf`

Other Writing

2024 **R. Lorch**, D. Larraz, C. Tinelli, "A Lustre Primer for Kind 2 Users."
`https://kind.cs.uiowa.edu/kind2_user_docs/lustre_primer.pdf`

Teaching

2021–2022 **Teaching Assistant**, *The University of Iowa*, Iowa City, IA.
Led discussion sessions, prepared solutions, graded, and held office hours.
- [CS:4420] Artificial Intelligence (Spring 2022)
- [CS:5810] Formal Methods of Software Engineering (Fall 2021)
- [CS:2640] Computer Organization (Fall 2021)

2021 **Peer Tutor**, *Grinnell College*, Grinnell, IA.
Led discussion sessions, prepared solutions, graded, and held office hours.
- [CSC-161] Imperative problem solving and data structures (Spring 2021)
- Conducted regular one-on-one tutoring sessions.

2021 **Class Mentor**, *Grinnell College*, Grinnell, IA.
Led discussion sessions, prepared solutions, graded, and held office hours.
- [CSC-207] Object-oriented problem solving, data structures, and algorithms (Spring 2021)
- Assisted with labs, answered questions, prepared course materials, and gave mentor sessions.

Presentations

2024 "A Comprehensive, Automated Security Analysis of the Uptane Automotive Over-the-Air Update Framework," *RAID*.

2023 "CRV: Automated Resiliency Reasoning for System Design Models," *FMCAD*.

2023 "Using LLMs to translate natural language to formalism," *GE Research Intern Poster Session*.

2021 "Strong proper connection," *Joint Mathematics Meetings*.

2019 "Steady and near-steady state cancer cell model," *Indiana Undergraduate Mathematics Research Conference*.

2019 "Steady and near-steady state cancer cell model," *IUPUI Poster Symposium*.

Awards

2023 **Delivering with Focus**, *GE Global Research*.

2022 **Academic Excellence in the Master's Program**, *The University of Iowa*.

2021 **Outstanding Poster**, *Joint Mathematics Meetings*.

2021 **Code Jam Wow Factor**, *Principal Financial Group*.

Service

Subreviewer IEEE S&P '24, '25; NDSS '25; TACAS '25

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