Ferhat Erata

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I am pursuing my PhD in Computer Science at Yale University under the guidance of Ruzica Piskac and Jakub Szefer. My recent research focuses on the dynamic inference of real-valued relational properties from programs by integrating machine learning with formal techniques. Additionally, I am exploring the application of these properties in areas such as side-channel security, property-based testing, self-correcting programs, testing of quantum circuits, and privacy-preserving machine learning.

I am an Applied Scientist Intern at the Automated Reasoning Group of Amazon Web Services (AWS) mentored by Rupak Majumdar. My work aims to improve the reliability of AWS services by creating advanced tools for model-based testing, conformance checking, and randomized testing of distributed networked systems.

My anticipated graduation date is 04/30/2025 (April 2025). I have successfully delivered industrial-strength software using Rust, Python, C++, and Java programming languages.

Education

PhD - Computer Science, Yale University:
• Concentration on Programming Languages and Verification

MPhil - Computer Science, Yale University:
• Master of Philosophy (MPhil) in Computer Science.

MSc - Computer Science, Yale University:
• Master of Science (MSc) in Computer Science.

Professional Experience

Amazon Web Services (AWS), Applied Scientist Intern [May 2023 -- January 2024]:
• Automated Reasoning Group, New York (https://www.amazon.science/research-areas/automated-reasoning)
• Rust Language: Systematic/Randomized Exploration, Model-based Testing, and Conformance Checking of Distributed Systems.

Amazon Web Services (AWS), Applied Scientist Intern [June 2022 -- January 2023]:
• Automated Reasoning Group, New York
• Rust and Go Languages: Fuzzing of Distributed Message-Passing Systems. Developed a decision procedure for checking linearizability of message-passing distributed systems.

Yale University, Graduate Research Assistant [June 2020 -- Present]:
• Member of Rigorous Software Engineering Lab. (Ruzica Piskac https://rose.yale.edu/)
• Member of Computer Architecture and Security Lab. (Jakub Szefer https://caslab.csl.yale.edu/)
• C/C++, LLVM, Rust, and ARM Binaries: Dynamic Analysis, Formal Verification, Property Synthesis, Symbolic Execution, Property-based Testing, Cryptographic Applications, Side-Channel analysis.

Yale University, Graduate Teaching Assistant [June 2020 -- Present]:
• CS423--Principles of Operating System (Instructor: Avi Silberschatz)
• CS437--Database Systems (Instructor: Avi Silberschatz)
• CS440--Advanced Databases (Instructor: Robert Soule)

ITEA, Research Engineer, National Consortium Leader [January 2019 -- August 2019]:
• ITEA Project Consortium (https://itea3.org/project/xivt.html)
• C++ Language: Tool Development using LLVM and KLEE Symbolic Execution Engine.
• I developed AlloyInEcore automated reasoning tool: https://modelwriter.github.io/AlloyInEcore/

• AlloyInEcore: Embedding of First-Order Relational Logic into Meta-object Facility. AlloyInEcore allows the user to specify metamodels with their static semantics, while, using the semantics, it automatically checks the conformance of models with their metamodel, detects inconsistent models, and completes partial models.

ITEA, Research Engineer, National Consortium Leader [September 2015 -- August 2018]:
• ASSUME Project Consortium (https://itea3.org/project/assume.html)
• C++ Language: Tool Development using SAT/SMT solvers.
• I developed Tarski framework: https://modelwriter.github.io/Tarski/

• Tarski: Automated Reasoning about Traces based on Configurable Formal Semantics: For any given artifact (e.g., requirements, architecture models and source code), Tarski allows the user to specify new trace types and their configurable semantics, while, using the semantics, it automatically infers new traces based on existing traces provided by the user, and checks the consistency of traces.

ITEA, Research Engineer, Project Leader [October 2014 -- September 2017]:
• ModelWriter Project Consortium (https://itea3.org/project/modelwriter.html)
• Java Language: Tool Development using Alloy Specification Language (https://modelwriter.github.io/Tarski/).
• I led the development of ModelWriter framework: https://ieeexplore.ieee.org/document/8115703

• ModelWriter: Text and model-synchronized document engineering platform: We demonstrate how ModelWriter framework can be used to trace the consistency and completeness of technical documents that consist of a set of System Installation Design Principles used by Airbus to ensure the correctness of aircraft system installation. We provide two types of reasoning: reasoning about the meaning of text using semantic parsing and description logic theorem proving; and reasoning about document structure using first-order relational logic and finite model finding.

Publications

[1] Ferhat Erata, Chuanqi Xu, Ruzica Piskac, and Jakub Szefer. **2024**. Recovering Quantum Circuits from Power Traces using Formal Methods. **Conference on Cryptographic Hardware and Embedded Systems (CHES 2024b).**

[2] Ferhat Erata, Ruzica Piskac, Victor Mateu, and Jakub Szefer. **2023**. "Towards Automated Detection of Single-Trace Side-Channel Vulnerabilities in Constant-Time Cryptographic Binaries". **Euro S&P 2023**. https://arxiv.org/abs/2304.02102

[3] Xu, Chuanqi, **Ferhat Erata**, and Jakub Szefer. **2023**. "Exploration of Quantum Computer Power Side Channels." **CCS 2023.** https://arxiv.org/abs/2304.03315

[4] Xu, Chuanqi, **Ferhat Erata,** and Jakub Szefer. "Classification of Quantum Computer Fault Injection Attacks." arXiv preprint arXiv:2309.05478 (2023). https://arxiv.org/abs/2309.05478

[5] Yusaf Azimi, Fırat, Atıl, Mohammad Celal Çağın Elgün, **Ferhat Erata**, and Cemal Yılmaz. **2024**. "AdapTV: A Model-Based Test Adaptation Approach for End." **IEEE Access** https://doi.org/10.1109/ACCESS.2023.3262746.

[6] Ferhat Erata, Shuwen Deng, Faisal Zaghloul, Wenjie Xiong, Onur Demir, and Jakub Szefer. **2022**. "Survey of Approaches and Techniques for Security Verification of Computer Systems". **ACM Journal on Emerging Technologies in Computing Systems (JETC)** https://doi.org/10.1145/3564785.

[7] Ferhat Erata, Arda Göknil, Sinan Yıldırım, Eren Yıldız, Ruzica Piskac, Jakub Szefer, and Gökçin Sezgín. **2022**. "Energy-aware Timing Analysis of Intermittent Programs". **ACM Transactions on Embedded Computing Systems (TECS)** https://dl.acm.org/doi/10.1145/3563216.

[8] Sanjay Deshpande, Chuanqi Xu, Theodoros Trochatos, Hanrui Wang, **Ferhat Erata**, Song Han, Yongshan Ding, and Jakub Szefer. **2023**. "Design of a Quantum Computer Antivirus". **IEEE International Symposium on Hardware Oriented Security and Trust (HOST)** https://doi.org/10.1109/HOST55118.2023.10133711

[9] Fırat, Atıl, Mohammad Yusaf Azimi, Celal Çağın Elgün, **Ferhat Erata**, and Cemal Yılmaz. "Model-based test adaptation for smart TVs." **AST 2022.** https://doi.org/10.1145/3524481.3527237

[10] Jalil Morris, Obi Nnorom Jr., Anisul Abedin, **Ferhat Erata**, and Jakub Szefer. **2021.** "Deep Freezing Attacks on Capacitors and Electronic Circuits", in Proceedings of the International Conference on **Security, Privacy and Applied Cryptographic Engineering (SPACE)**, December. https://doi.org/10.1007/978-3-030-95085-9_10 (**Best Student Paper Award**). http://cse.iitkgp.ac.in/conf/SPACE2021/best_papers.php

[11] Mert Ozkaya and **Ferhat Erata. 2020**. "Understanding practitioners' challenges on software modeling: A survey." **Journal of Computer Languages** 58: 100963. https://doi.org/10.1016/j.cola.2020.100963.

[12] Mert Ozkaya and **Ferhat Erata**. **2019**. A Survey on the Practical Use of UML for Different Software Architecture Viewpoints. **Information and Software Technology**. https://doi.org/10.1016/j.infsof.2020.106275

[13] Bedir Tekinerdogan and **Ferhat Erata. 2019**. Automated Reasoning Framework for Traceability Management of System-of-Systems. **Science of Computer Programming** https://doi.org/10.1016/j.scico.2020.102416

[14] Ferhat Erata, Arda Goknil, Ivan Kurtev, and Bedir Tekinerdogan. **2018**. "AlloyInEcore: Embedding of First-Order Relational Logic into Meta-Object Facility for Automated Model Reasoning", **ESEC/FSE 2018**. https://doi.org/10.1145/3236024.3264588

[15] Ferhat Erata, Claire Gardent, Bikash Gyawali, Anastasia Shimorina, Yvan Lussaud, Bedir Tekinerdogan, Geylani Kardas and Anne Monceaux. **2017**. Modelwriter: Text and model-synchronized document engineering platform. **ASE 2017**. https://doi.org/10.1109/ASE.2017.8115703

[16] Ferhat Erata, Arda Goknil, Bedir Tekinerdogan, and Geylani Kardas. **2017**. A tool for automated reasoning about traces based on configurable formal semantics. **ESEC/FSE 2017**. https://doi.org/10.1145/3106237.3122825

[17] Matthias Kern, **Ferhat Erata**, Stefan Otten, Eric Sax, Markus Iser, Carsten Sinz, and Frederic Loiret. **2019**. Integrating Static Code Analysis Toolchains. In Proceedings of the IEEE 43rd Annual Computer Software and Applications Conference (**COMPSAC'19**). https://doi.org/10.1109/COMPSAC.2019.00080

[18] Ferhat Erata, Moharram Challenger, Bedir Tekinerdogan, Anne Monceaux, Eray Tuzun, and Geylani Kardas. **2017**. Tarski: a platform for automated analysis of dynamically configurable traceability semantics. **SAC 2017.** https://doi.org/10.1145/3019612.3019747

Service

COST (European Cooperation in Science and Technology), Management Committee Member:
[December 2017 -- January 2019]
• COST Action IC1402 - Runtime Verification beyond Monitoring (ARVI)
• https://www.cost.eu/actions/IC1402/

COST (European Cooperation in Science and Technology), Management Committee Member:
[January 2015 -- January 2019]
• COST Action IC1404 - Multi-Paradigm Modelling for Cyber-Physical Systems (MPM4CPS)
• https://www.cost.eu/actions/IC1404/

Journal of Automated Reasoning (IF: 1.532).
• Reviewer • https://www.springer.com/journal/10817

IEEE Computer Architecture Letters (IF: 2.118).

• Reviewer • https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10208

International Conference on Computer Aided Verification (CAV) 2023.
• PC member (AE) • http://www.i-cav.org/2023/organisation/

24th International Conference on Verification, Model Checking, and Abstract Interpretation (VMCAI 2023):
• PC member (AE) • https://popl23.sigplan.org/committee/VMCAI-2023-papers-artifact-evaluation-committee

International Workshop on Multi-Paradigm Modelling for Cyber-Physical Systems (MPM4CPS):
• PC member • http://msdl.uantwerpen.be/conferences/MPM4CPS/2023/50_committees

FedCSIS:
• PC member (Software, System and Service Engineering) • https://fedcsis.org/sessions/s3e/committee