Ferhat Erata

Neuro-Symbolic AI, AI4Code, GenAI Anti-Hallucination, and Security & Privacy

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Education

Yale University – PhD in Computer Science | **New Haven, CT, US**
Advisors: Prof. Ruzica Piskac, Prof. Jakub Szefer | *Anticipated Graduation Date: 04/25*

Yale University – MSc, MPhil in Computer Science | **New Haven, CT, US**

Ege University – MSc in Information Technologies | **Bornova, Izmir, TR**

Dokuz Eylul University – BSc in Computer Science & Industrial Engineering (Double Major) | **Bornova, Izmir, TR**

Work Experience

Amazon AI – Automated Reasoning Group | **New York, NY, US**
Applied Scientist Intern | *May 2024 - Dec. 2024*

- Working on Neuro-Symbolic program synthesis to capture symbolic knowledge using Large Language Models (LLMs), focusing on detecting hallucinations in math and logical reasoning. Co-inventor, along with Rémi Delmas and Sam Bayless, of a **US Patent** filed on hallucination detection and mitigation for LLM-generated symbolic math and logic output).

Amazon AI – Automated Reasoning Group | **New York, NY, US**
Applied Scientist Intern | *May 2023 - Jan. 2024*

- Developed a scheduler framework for randomized testing, model-based testing, and conformance checking of distributed AWS Services in **Rust** programming language. Deployed to the testing workflow of a distributed journal management system.

Amazon AI – Automated Reasoning Group | **New York, NY, US**
Applied Scientist Intern | *Jun. 2022 - Jan. 2023*

- Developed a decision procedure in **Rust** programming language for checking linearizability and sequential consistency of distributed systems. Deployed the tool to S3's model-based testing workflows.

Yale University | **New Haven, CT, US**
Research Assistant & Teaching Fellow | *Sep. 2019 - Present*

- Conducted research on program security analysis for cryptographic **C** code and quantum computers using formal methods and machine learning. Developed a static leakage analysis tool for binaries and a probabilistic symbolic execution engine for **LLVM**. Implemented a tool for automated inference of loop invariants and post conditions in **C/C++** programs using ML.
- Worked as Teaching Fellow for *CS423–Operating System* and *CS437–Database Systems* of Prof. Avi Silberschatz.

UNIT Research & Development Ltd. | **Ege University, TR**
Co-founder & Software Engineer | *Jan. 2014 - June 2019*

- Developed software engineering tools for *Airbus, Daimler,* and *Ford* in European R&D collaborations. Led the *ModelWriter: Text & Model-Synchronized Document Engineering Platform* project (see `https://itea3.org/project/modelwriter.html`) and coordinated a sub-consortium in the *Assume: Safe & Secure Mobility Evolution* project (see `https://itea3.org/project/assume.html`) and *XIVT: eXcellence In Variant Testing* (see `https://itea3.org/project/xivt.html`). Mainly used **Java**, **C++** and formal specification languages such as **Alloy**, model checking and **SAT/SMT** solving.

Programming Languages

Programming: Rust, Python, C, C++, Java, Go, R, Dafny, Alloy **Others**: PyTorch, Sympy, Scikit-learn, LLVM, Triton, Angr, KLEE

Project & Research Experience

Legal Reasoning using Large Language Models (LLMs) and Theorem Provers | **2024 - Present**

- Researching a Neuro-Symbolic AI approach for logical reasoning of legal documents by combining LLMs with First-Order Logic (FOL) theorem provers, in collaboration with Yale Law School (Prof. Scott Shapiro).

Automated Inference of Program Properties using Machine Learning | **2023 - Present**

- Introduced a machine learning technique for learning randomized reductions and program invariants. This work is currently under review [1]. Developed a C language wrapper at `https://bitween.fun`. Applied these techniques to hardware security (*ICCAD 2025* [2]) and Privacy-Preserving Machine Learning (PPML).

Side-Channel Insecurity of Cryptographic Code and Quantum Computer Security | **2019 - 2023**

- Researched on verifying the side-channel insecurity of low-level Post-Quantum Cryptographic code (*EuroS&P 2023* [3]); developing software countermeasure against physical attacks (*ICCAD 2025* [2]); worked on reverse engineering quantum circuits from power side-channel traces (*CHES 2024* [4], *CCS 2023* [5]); developed techniques to model and quantify non-functional behaviors of intermittent programs (*TECS 2023* [6]); surveyed security verification techniques (*JETC 2023* [7]).

Applied Research & Software Development in Aviation and Automotive Sectors   **2014 - 2019**

o Developed the open-source AlloyInEcore tool that automatically checks correctness of system models (*FSE 2018* [8])
  (see `https://modelwriter.github.io/AlloyInEcore/`).
o Developed the open-source Tarski tool that formalizes relationships between software development artifacts (*FSE 2017* [9])
  (see `https://modelwriter.github.io/Tarski/`).
o Leadership in the development of ModelWriter–Text & Model-Synchronized Document Engineering Platform (*ASE 2017* [10])
  (see `https://itea3.org/project/modelwriter.html`).

Grants Awarded

NSF – U.S. National Science Foundation, Secure & Trustworthy Cyberspace Program   **[Award Link]**
SaTC: Automatic Detection and Repair of Side Channel Vulnerabilities in Software Code   *Jul. 2023 – Jun. 2026*
o Contributed to the proposal writing and partly working on the project as a PhD student. Award no: 2245344; amount: $600,000

EUREKA – EU. Information Technology for European Advancement (ITEA)   **[Project Link]**
ASSUME: Affordable Safe & Secure Mobility Evolution   *Sept. 2015 – Dec. 2018*
o R&D project with 38 partners from Canada, Germany, Portugal, Sweden, and Turkey, with ITEA project no. 17039.
o My start-up was awarded by TUBITAK Intl. Industrial R&D Projects Grant Programme. Project no: 9150181, amount: $250,000.

EUREKA – EU. Information Technology for European Advancement (ITEA)   **[Project Link]**
ModelWriter: Text & Model-Synchronized Document Engineering Platform   *Nov. 2015 – Nov. 2017*
o R&D project with with 9 partners from France and Turkey, with ITEA project no: 13028.
o My start-up was awarded by TUBITAK Intl. Industrial R&D Projects Grant Programme. Project no: 9140014, amount: $300,000.

Leadership and Awards

Yale University – *Full Scholarship for PhD*   **Aug. 2019 - Aug. 2025**
Awarded a full scholarship for doctoral studies in Computer Science

Short-Term Scientific Missions – *European Cooperation in Science and Technology*   **Jun. 2018 – Sep. 2018**
o University of Antwerp, Belgium: Full grant for a short-term scientific mission to visit Modeling, Simulation and Design lab.
o Chalmers University of Technology, Gothenburg, Sweden: Full grant to visit the Division of Formal Methods.

Management Committee Member – *European Cooperation in Science and Technology*   **2015 - 2019**
o Action IC1404 - Multi-Paradigm Modelling for Cyber-Physical Systems (MPM4CPS) (`https://www.cost.eu/actions/IC1404/`)
o Action IC1402 - Runtime Verification beyond Monitoring (ARVI) (`https://www.cost.eu/actions/IC1402/`)

Selected Publications

[1] **Ferhat Erata**, Orr Paradise, Timos Antonopoulos, ThanhVu Nguyen, Shafi Goldwasser, and Ruzica Piskac. Learning randomized reductions and program properties. 2025. (*under review*).

[2] **Ferhat Erata**, TingHung Chiu, Anthony Etim, Srilalith Nampally, Tejas Raju, Rajashree Ramu, Ruzica Piskac, Timos Antonopoulos, Wenjie Xiong, and Jakub Szefer. Systematic use of random self-reducibility in cryptographic code against physical attacks. In *IEEE/ACM International Conference on Computer-Aided Design* (**ICCAD**), 2024.

[3] **Ferhat Erata**, Ruzica Piskac, Victor Mateu, and Jakub Szefer. Towards automated detection of single-trace side-channel vulnerabilities in constant-time cryptographic code. In *IEEE European Symposium on Security and Privacy* (**EuroS&P**), 2023.

[4] **Ferhat Erata**, Chuanqi Xu, Ruzica Piskac, and Jakub Szefer. Quantum circuit reconstruction from power side-channel attacks on quantum computer controllers. *IACR Transactions on Cryptographic Hardware and Embedded Systems* (**TCHES**), 2024.

[5] Chuanqi Xu, **Ferhat Erata**, and Jakub Szefer. Exploration of power side-channel vulnerabilities in quantum computer controllers. In *Proceedings of the 2023 ACM SIGSAC Conference on Computer and Communications Security* (**CCS**), 2023.

[6] **Ferhat Erata**, Eren Yildiz, Arda Goknil, Kasim Sinan Yildirim, Jakub Szefer, Ruzica Piskac, and Gokcin Sezgin. Etap: Energy-aware timing analysis of intermittent programs. *ACM Transactions on Embedded Computing Systems* (**TECS**), 2023.

[7] **Ferhat Erata**, Shuwen Deng, Faisal Zaghloul, Wenjie Xiong, Onur Demir, and Jakub Szefer. Survey of approaches and techniques for security verification of computer systems. *ACM Journal on Emerging Technologies in Computing Systems* (**JETC**), 2023.

[8] **Ferhat Erata**, Arda Goknil, Ivan Kurtev, and Bedir Tekinerdogan. AlloyInEcore: embedding of first-order relational logic into meta-object facility. In *Proceedings of the Symposium on the Foundations of Software Engineering* (**ESEC/FSE**), 2018.

[9] **Ferhat Erata**, Arda Goknil, Bedir Tekinerdogan, and Geylani Kardas. A tool for automated reasoning about traces based on configurable formal semantics. In *Proceedings of the Foundations of Software Engineering* (**ESEC/FSE**), 2017.

[10] **Ferhat Erata**, Claire Gardent, Bikash Gyawali, Anastasia Shimorina, Yvan Lussaud, Bedir Tekinerdogan, Geylani Kardas, and Anne Monceaux. ModelWriter: Text and model-synchronized document engineering platform. In *Proceedings of the Automated Software Engineering* (**ASE**), 2017.