

# Alessandro Baccarini

## Contact Information

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🏆 Scholar 1194 citations, Aug. 2025

## Research Interests

My interests span across areas of information security, applied cryptography, and privacy-enhancing technologies. Concretely, I design and implement protocols for secure multi-party computation (MPC) and its application to privacy-preserving machine learning, compliance monitoring, and outsourcing. I simultaneously investigate mechanisms for quantifying private information leakage from secure computation. I am also interested in post-quantum cryptographic techniques.

## Education

**PhD, Computer Science**, University at Buffalo Aug. 2024  
Advisor: Marina Blanton  
**MS, Cybersecurity**, Fordham University May 2019  
Advisor: Thaier Hayajneh  
**BS, Physics**, Fordham University May 2017  
Minor in Mathematics

## Work Experience

**Principal Consultant**, Cryptography and Security Sept. 2024 – Present  
Guardian Cryptography LLC  
**Research Assistant**, Computer Science Jun. 2019 – Aug. 2024  
University at Buffalo  
**Teaching Assistant**, Computer Science Jan. 2020 – May 2022  
University at Buffalo  
**Adjunct Assistant Professor**, Physics Aug. 2017 – May 2019  
Fordham University  
**Graduate Research Assistant**, Cybersecurity Aug. 2017 – May 2019  
Fordham University

## Awards and Recognition

**Alan Selman Scholarship**, University at Buffalo 2024  
First place \$2000 cash prize, focus in theoretical computer science.

**GSAS Centennial Scholarship**, Fordham University 2017 – 2019  
Full tuition support and stipend (academic year + summer).

## Experience

**Principal Consultant** Sept. 2024 – Present  
Guardian Cryptography

- Provide expert consulting in applied cryptography, privacy-enhancing technologies, and secure software development for startups, research teams, and enterprise clients.

**Threshold Decryption for FHE** Sept. 2024 – Dec. 2024  
Guardian Cryptography. Client: Blockchain R&D Organization

- Analyzed distributed threshold decryption protocols for multi-party fully homomorphic encryption (FHE) schemes with application to private smart contract deployment on Ethereum-like blockchains.
- Implemented and evaluated an actively secure threshold decryption construction based on Shamir secret sharing over Galois rings in C++, obtaining an up to  $4\times$  performance improvement over prior works.
- Designed a general-purpose threshold distributed key generation protocol compatible with various multi-party FHE schemes, and implemented it within the MP-SPDZ framework.

**PICCO Compiler** 2022 – Present  
University at Buffalo, later Guardian Cryptography [Repository](#)

- Core developer and maintainer of PICCO, a source-to-source secure multi-party computation (MPC) compiler library that translates general-purpose programs into secure distributed equivalents.
- Integrated ring-based constructions into the compiler to support general-purpose secure computation over diverse input domains and broaden application flexibility.
- Performed extensive optimizations to existing field-based protocols and led a large-scale refactor of over 100k lines of code to enhance long-term maintainability and enable support for stronger security models.
- Mentored undergraduate REU students on projects including optimizing and parallelizing networking layers across parties, and developing a web interface to facilitate secure input/output interactions.

**MPC and Privacy-Preserving Machine Learning** Jan. 2020 – July 2023  
University at Buffalo [Repository](#)

- Designed a novel comprehensive ring-based framework of replicated secret sharing MPC protocols for an arbitrary number of parties in the semi-honest (passively secure), honest majority setting.
- Implemented protocols in C++, applying extensive profiling and low-level optimizations that led to up to  $33\times$  performance improvements over state-of-the-art secret sharing techniques.

- Applied MPC to privacy-preserving machine learning tasks, including (quantized) convolutional deep neural network (CNN/DNN) inference and support vector machine (SVM) classification.
- Discovered an algebraic optimization for secure quantized inference that minimizes the overall ring modulus across multiple layer evaluations, yielding over  $2\times$  performance improvement on average.

### Secure Computation Information Disclosure Analysis

Jan. 2021 – Present

University at Buffalo

[Repository](#)

- Developed an information-theoretic technique to quantify leakage about private inputs from arbitrary secure computation outputs, enabling practical assessment of residual disclosure under complex function evaluation.
- Analyzed common statistical functions under practical MPC configurations and proposed concrete mitigation strategies for real-world deployment.
- Combined the methodology with entropy estimation techniques using machine learning to assess leakage from complex descriptive statistical measures (e.g., variance, order statistics).
- Awarded first place Alan Selman Scholarship in theoretical computer science for this work, recognized for its combination of rigorous theory and real-world relevance to secure data analysis.

### Blockchain Applications in Healthcare

Aug. 2017 – May 2019

Fordham University

- Led the design of the first framework that fused blockchain and healthcare into a HIPAA-compliant IoT remote patient monitoring system, based on the Ethereum protocol.
- Contributed to Solidity-based prototype development supporting automated, real-time patient data tracking.

## Publications

### Thesis

- [1] **Alessandro Baccarini**. *New Directions in Secure Multi-Party Computation: Techniques and Information Disclosure Analysis*. PhD thesis, University at Buffalo, 2024.

### Conference Proceedings

- [2] **Alessandro Baccarini**, Marina Blanton, and Shaofeng Zou. Understanding information disclosure from secure computation output: A study of average salary computation. In *ACM Conference on Data and Application Security and Privacy (CODASPY)*, pages 187–198, 2024.
- [3] **Alessandro Baccarini** and Thaier Hayajneh. Evolution of format preserving encryption on IoT devices: FF1+. In *Hawaii International Conference on System Sciences (HICSS)*, pages 1628–1637, 2019.
- [4] Abdullah Alhayajneh, **Alessandro Baccarini**, and Thaier Hayajneh. Quality of service analysis of VoIP services. In *IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, pages 812–818, 2018.

## Refereed Journals

- [5] **Alessandro Baccarini**, Marina Blanton, and Shaofeng Zou. Understanding information disclosure from secure computation output: A comprehensive study of average salary computation. *ACM Transactions on Privacy and Security (TOPS)*, 28(1):1–36, 2024.
- [6] **Alessandro Baccarini**, Marina Blanton, and Chen Yuan. Multi-party replicated secret sharing over a ring with applications to privacy-preserving machine learning. *Proceedings on Privacy Enhancing Technologies (PoPETs)*, 2023(1):608–626, 2023.
- [7] Abdullah Alhayajneh, **Alessandro Baccarini**, Gary Weiss, Thaier Hayajneh, and Aydin Farajidavar. Biometric authentication and verification for medical cyber physical systems. *Electronics*, 7(12):436, 2018.
- [8] Kristen Griggs, Olya Ossipova, Christopher Kohlios, **Alessandro Baccarini**, Emily Howson, and Thaier Hayajneh. Healthcare blockchain system using smart contracts for secure automated remote patient monitoring. *Journal of Medical Systems*, 42(7):130, 2018.

## Technical Presentations

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|--|-----------|
| • RAND Corporation, Engineering & Applied Sciences Dept. Virtual.        | Apr. 2025 |
| • Intel Labs, Security & Privacy Research Group. Virtual.                | Mar. 2025 |
| • Riverside Research, Secure & Resilient Systems Group. Lexington, MA.   | Feb. 2025 |
| • MITRE Corporation, Cyber for Identity Trust & Assurance Dept. Virtual. | Jan. 2025 |
| • Dissertation defense, University at Buffalo. Buffalo, NY.              | July 2024 |
| • ACM CODASPY 2024. Porto, Portugal.                                     | June 2024 |
| • PETS 2023. Lausanne, Switzerland.                                      | July 2023 |
| • Great Lakes Security Day, RIT. Rochester, NY.                          | Apr. 2023 |
| • IEEE UEMCON 2018. New York, NY.  | Nov. 2018 |

## Professional Service

### Conference Committees

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|--|------------|
| IEEE Symposium on Security and Privacy, poster jury      | 2025       |
| USENIX Security Symposium, artifact evaluation committee | 2023, 2024 |

### Refereeing

- Journal of Computer and System Sciences (JCSS)
- IEEE Transactions on Information Forensics and Security (TIFS)
- IEEE Transactions on Dependable and Secure Computing (TDSC)
- European Symposium on Research in Computer Security (ESORICS)
- IEEE/ACM International Conference on Automated Software Engineering (ASE)
- Hawaii International Conference on System Sciences (HICSS)

## Technical Skills

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|----------------------|---|
| <b>Cryptographic</b> | secure multi-party computation, secret sharing, homomorphic encryption, lattice cryptography, zero-knowledge proofs, differential privacy, information theory |
| <b>Languages</b>     | C/C++, Python, Rust, Bash, Lua, $\text{\LaTeX}$   |
| <b>Developer</b>     | Version control (Git, SVN), CMake, Make, GDB, Valgrind, Neovim, VS Code   |
| <b>Platforms</b>     | Docker, AWS EC2, GitHub, HPC Clustering, Linux, Unix, Windows   |
| <b>Libraries</b>     | GMP, GMPFR, GSL, STL, OpenSSL, SageMath, MP-SPDZ, NumPy, Pandas, SciPy, Matplotlib, TensorFlow  |

## Teaching

At the **University at Buffalo**:

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|--|-------------|
| CSE 116 Computer science II (Instructor)               | 2 semesters |
| CSE 4/529 Algorithms for Modern Computing Systems (TA) | 3 semesters |
| CSE 4/531 Analysis of Algorithms (TA)                  | 1 semester  |
| CSE 542 Software Engineering Concepts (TA)             | 1 semester  |

At **Fordham University**:

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| PHYS 1511/12 Physics I/II Lab (Instructor) | 4 semesters |
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