

Ryan Lehmkuhl

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I am interested in using cryptography to build decentralized and privacy-preserving systems.

EDUCATION

UC BERKELEY | *B.S. Electrical Engineering and Computer Science*
Class of 2021 • GPA 3.9/4.0

RELEVANT COURSEWORK

CS294-153	Foundations of Probabilistic Proofs
CS294-163	Decentralized Security: Theory and Systems
CS261	Systems Security
CS161	Computer Security
CS171	Cryptography
CS170	Efficient Algorithms & Intractable Problems
CS162	Operating Systems
CS188	Artificial Intelligence
EECS126	Probability and Random Processes
Math 113 & 114	Abstract Algebra I & II

AWARDS AND HONORS

2022:	NSF Graduate Fellowship	
2021:	NSF Graduate Fellowship Honorable Mention	
2020:	CRA Outstanding Undergraduate Researcher Finalist	<i>Top 32 undergraduate CS researchers in the nation</i>
2020:	UC Berkeley EECS Outstanding GSI Award	<i>Top 10% of student instructors</i>
2019:	UC Berkeley Summer Undergraduate Research Fellowship	<i>21 students selected (I was the only EECS major chosen)</i>
2017:	UC Berkeley Regents' and Chancellor's Scholarship	<i>Top <1% of incoming students</i>

PUBLICATIONS

- [1] **Ryan Lehmkuhl**, Pratyush Mishra, Akshayaram Srinivasan, and Raluca Ada Popa. "Muse: Secure CNN inference for malicious clients". USENIX Security '21.
- [2] Pratyush Mishra, **Ryan Lehmkuhl**, Akshayaram Srinivasan, Wenting Zheng, and Raluca Ada Popa. "Delphi: A cryptographic inference service for neural networks". USENIX Security '20.

TEACHING

Summer 2020	Co-instructor for CS161 (Computer Security)
Spring 2020	Teaching Assistant for CS161 (Computer Security)
Summer 2019	Teaching Assistant for CS161 (Computer Security)

RESEARCH

PRIVATE DELEGATION OF ZKSNARK PROVERS | *RISELab, UC Berkeley* **September 2020 - Present**
Working under [Professor Alessandro Chiesa](#) on efficient delegation of zero-knowledge, succinct, non-interactive arguments of knowledge (zkSNARKs). Our delegation scheme reduces a prover's computational overhead by up to $26\times$ and memory cost by upwards of $256\times$. In submission USENIX Security 2022.

MUSE | *RISELab, UC Berkeley* **September 2019 - Present**
Worked under [Professor Raluca Ada Popa](#) on malicious-client secure inference. We demonstrate a devastating attack against many prior semi-honest secure inference protocols which allows a malicious client to perfectly extract the server's model upwards of $312\times$ faster than prior attacks. Motivated by this, we design Muse, an efficient secure inference protocol secure against malicious clients. Muse outperforms existing works by up to $21\times$ and uses up to $3.6\times$ less communication.

Worked under [Professor Raluca Ada Popa](#) and [Pratyush Mishra](#) on semi-honest secure inference. Through a careful co-design of cryptography, machine learning, and systems, Delphi is up to 100x faster, uses 40x less bandwidth, and scales to networks 10x larger than prior work.

PROJECTS

DELEGATED PROVING | *Efficient Delegation of SNARK Provers – Rust* September 2020 - Present

- Designed an asynchronous MPC system for handling computation on secret-shared polynomials
- Extending the [poly-commit](#) and [Marlin](#) libraries to support delegation
- Building a delegation framework for constructing zkSNARKS through a distributed network of workers

POLY-COMMIT | *Multivariate Polynomial Commitment Scheme – Rust* August 2020 - Present

- Designed and implemented a [multivariate polynomial commitment scheme](#) for the [poly-commit](#) library

MUSE | *Client-Malicious Secure Inference – Rust, C++* September 2019 - Present

- Implemented an efficient modular reduction algorithm for garbled circuits
- Building a multi-threaded, asynchronous, two-party computation framework secure against malicious clients

DELPHI | *Semi-Honest Secure Inference – Rust, C++, Python* September 2018 – September 2019

- Developed new approaches for training convolutional neural networks that are performant with cryptographic techniques using Keras and RayTune
- Built a secure two-party protocol for convolution and matrix multiplication using fully homomorphic encryption with Microsoft's SEAL library
- Implemented a novel cryptographic protocol and inference engine ([Source Code](#))

GENETIC SCHEDULE | *Genetic Algorithm for Scheduling – Python* Winter 2019

- Finds an optimal auditioning schedule for [DeCadence A Cappella](#) ([Source Code](#))

SCRYPTO | *Secure File Encryptor/Decryptor – Rust, Python* Summer 2018

- Password-protected authenticated file encryption using AES-GCM and PBKDF2 ([Source Code](#))

SECURE FILE STORE (CS161) | *Maliciously-Secure Shared File Store – Python, Go* Spring 2018

- Fully encrypted database with hierarchical sharing/revocation and efficient updates using a Merkle Tree

SCADA NETWORK TCP SESSION HIJACKER | *MITM exploit – Python* Summer 2016

- Concurrently executes ARP cache poisoning and TCP session hijacking to hack a Navy SCADA controller

EXPERIENCE

OPAQUE | *Software Engineer* Spring 2021 – Present

- Constructing efficient systems for private data analytics utilizing hardware enclaves.

CIRCADENCE | *Research and Development Intern* Summers 2017, 2018

- Researched and developed cellular network attacks utilizing software-defined radios

NAVWAR | *Research and Development Intern* Summers 2015, 2016

- Performed vulnerability analysis that helped earn over \$200,000 in lab funding

WORKSHOPS

DELPHI | *A Cryptographic Inference Service for Neural Networks*

- CCS Privacy-Preserving Machine Learning in Practice (PPMLP)
- Theory and Practice of Multi-Party Computation (TPMPC)

November 2020

May 2020

MUSE | *Secure Inference Resilient to Malicious Clients*

- CCS Privacy-Preserving Machine Learning in Practice (PPMLP)

August 2021