Jason Gross

Email: jgross@mit.edu
Website: people.csail.mit.edu/jgross
GitHub: JasonGross
Google Scholar: QouPlrMAAAAJ

ABOUT ME

I'm a programming languages research scientist transitioning into ML and alignment. I have a working knowledge of around two dozen programming languages, and expertise in a handful (Coq ($\approx$1M+ loc), Python ($\approx$50k loc), Agda ($\approx$50k loc), others). I spent my PhD on low-level cryptographic code generation, proof automation, performance engineering, and infrastructure around debugging and CI. My current project is in mechanistic interpretability, heuristic arguments, and compact proofs. I'm excited about what scalable performant automation can make possible.

EXPERIENCE

Special Project of ARC Theory   August 2023–Present
Project Lead   Berkeley, CA
- Building the first machine-checked functional-correctness proofs of mechanistic interpretability arguments about transformers in Coq (`github.com/JasonGross/neural-net-coq-interp`)
- Raised $150k & leading an interdisciplinary team of eight ML researchers and mathematicians

Machine Intelligence Research Institute (MIRI)   February 2021–September 2023
Research Staff   Berkeley, CA (remote)
- Performing self-directed research into fundamental programming language theory and math

Coq Development Team, INRIA   June 2021–Present
Member of Core Team   Nantes, France (remote)
- Reported the plurality of all-time bugs in Coq (since 2012)
- Designed and engineered a bug report minimizer for automatically producing minimized standalone test-cases and minimizing regressions in external projects tested by Coq's CI
- Researching performance issues that impact scalability of automated verification

MIT CSAIL   September 2013–February 2021
PhD Researcher   Cambridge, MA
- Main Project: Fiat Cryptography (`github.com/mit-plv/fiat-crypto`)
- Fiat Cryptography is a developer tool to generate proven-correct cryptographic code, with wide industry adoption, powering the plurality of secure connections in Chrome and Firefox
- Lead development of one of the world's first algorithm-level-optimizing compilers
- Collaboratively implemented the tool; wrote backends to C, Go, Java, and JSON; managed development of backends to Rust and Zig

EDUCATION

Massachusetts Institute of Technology   2013–2021
PhD in Computer Science   Cambridge, MA
Advisor: Adam Chlipala
Thesis: Performance Engineering of Proof-Based Software Systems at Scale
SM Thesis: An Extensible Framework for Synthesizing Efficient, Verified Parsers

Massachusetts Institute of Technology   2009–2013
BS in Mathematics and Physics   Cambridge, MA
GPA: 4.6/5

INTERNSHIPS

- MIRI, summer 2019: Formalized type theories, and proved properties of programs that reason about themselves
- Google, summer 2018: Worked on integration of Fiat Cryptography with BoringSSL in Chrome
- Google, summer 2016: Extended Fiat Cryptography with ECC primiatives for integration with Open Titan
- Microsoft Research, summer 2014: Collaboratively created a language for specifying input/output behavior of x86 assembly programs, verfied the input/output behavior of a number of simple programs, and improved performance of the x86proved project
- MIT CSAIL — PLV, 2012–2014: Entered a significant amount of category theory into the automated proof assistant Coq, and worked on building an interface for databases and database migration on top of category theory
- MIT CSAIL — CoCoSci, 2009–2011: Designed and managed the data collection webpage for research in categorical learning and transfer learning
- Commack High School, 2006–2009: Researched circuits over sets of natural numbers, winning 4th (2009) and 3rd (2008) place awards in mathematics at ISEF

PROFESSIONAL ACTIVITIES

- Co-maintainer of the Fiat Cryptography project
- Co-maintainer of the homotopy type theory Coq repository (`HoTT/HoTT` on GitHub)
- Program Committee Member of ITP 2023 and CoqPL 2022
- Supervising research in formalizing correspondence of affine logic to two-player games
- Supervising research in anti-inductive utility functions
- Supervising research in performative power of predidiction markets
- Circling Facilitator at The Relateful Company
- Member of SIPB (Student Information and Processing Board)

SELECT PAST ACTIVITIES

- Particpant in MIRI Decision Theory Workshops
- Volunteer at CFAR workshops
- Instructor at MIT ESP Programs
- Instructor at Monsoon Math Camp
- President of MIT Tech Squares
- Contributor to the SIPB BarnOwn project
- Project leader for MITeX, an online interface for composing LaTeX
- TA for 6.172: Performance Engineering
- TA for 8.012: Physics I and 8.022: Physics II at the Experimental Study Group
- Participant at Cananda/USA Mathcamp

PROGRAMMING LANGUAGES

- Proficient: Coq, Agda, Python, Mathematica, BASIC, TeX macro language, git, JavaScript
- Working knowledge: C, C++, OCaml, Haskell, Scheme, HTML, CSS, Perl, Bash, Java
- Basic knowledge: MATLAB, Lean, Idris, Ruby, Go, Ur/Web, x86 Assembly, SQL, Batch

Selected Presentations and Publications

[Gro+24]   Jason Gross, Rajashree Agrawal, Thomas Kwa, Euan Ong, Chun Hei Yip, Alex Gibson, Soufiane Noubir, and Lawrence Chan. *Provable Guarantees for Model Performance via Mechanistic Interpretability*. June 2024. DOI: `10.48550/arxiv.2406.11779`. arXiv: `2406.11779`.

[Gro24]   Jason Gross. *Guarantees-Driven Mechanistic Interpretability: Formal Proof Size as a Metric for Mechanistic Detail of Understanding*. Presented at FAR AI's weekly seminar. Feb. 2024.

[Gro+23]   Jason Gross, Andres Erbsen, Jade Philipoom, Rajashree Agrawal, and Adam Chlipala. "Towards a Scalable Proof Engine: A Performant Prototype Rewriting Primitive for Coq". In: *Selected Extended Papers of ITP 2022 in the Journal of Automated Reasoning* (2023). arXiv: `2305.02521 [cs.PL]`.

[Gro23]   Jason Gross. *MetaCoq Quotation: Partial Work Towards Löb's Theorem*. Presented remotely to the Gallinette team in Nantes at an informal workshop on meta-programming and modal type theories with native quotation operations. Oct. 2023.

[Kue+23]   Joel Kuepper, Andres Erbsen, Jason Gross, Owen Conoly, Chuyue Sun, Samuel Tian, David Wu, Adam Chlipala, Chitchanok Chuengsatiansup, Daniel Genkin, Markus Wagner, and Yuval Yarom. "CryptOpt: Verified Compilation with Random Program Search for Cryptographic Primitives". In: *PLDI'23: Proceedings of the 44th ACM SIGPLAN Conference on Programming Language Design and Implementation*. Distinguished Paper Award. Orlando, FL, USA, June 2023. arXiv: `2305.19586`. URL: `http://adam.chlipala.net/papers/CryptoptPLDI23/`.

[GE22]   Jason Gross and Andres Erbsen. *10 Years of Superlinear Slowness in Coq*. Presented at The Coq Workshop 2022. Aug. 2022. URL: `https://jasongross.github.io/papers/2022-superlinear-slowness-coq-workshop.pdf`.

[Gro+22a]   Jason Gross, Andres Erbsen, Jade Philipoom, Miraya Poddar-Agrawal, and Adam Chlipala. "Accelerating Verified-Compiler Development with a Verified Rewriting Engine". In: *Proceedings of the 13th International Conference on Interactive Theorem Proving (ITP 2022)*. Ed. by June Andronick and Leonardo de Moura. Vol. 237. Leibniz International Proceedings in Informatics (LIPIcs). Dagstuhl, Germany: Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Aug. 2022, 17:1–17:18. ISBN: 978-3-95977-252-5. DOI: `10.4230/LIPIcs.ITP.2022.17`. eprint: `2205.00862`. URL: `https://jasongross.github.io/papers/2022-rewriting-itp.pdf`.

[Gro+22b]   Jason Gross, Théo Zimmermann, Miraya Poddar-Agrawal, and Adam Chlipala. "Automatic Test-Case Reduction in Proof Assistants: A Case Study in Coq". In: *Proceedings of the 13th International Conference on Interactive Theorem Proving (ITP 2022)*. Ed. by June Andronick and Leonardo de Moura. Vol. 237. Leibniz International Proceedings in Informatics (LIPIcs). Dagstuhl, Germany: Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Aug. 2022, 18:1–18:18. ISBN: 978-3-95977-252-5. DOI: `10.4230/LIPIcs.ITP.2022.18`. URL: `https://jasongross.github.io/papers/2022-coq-bug-minimizer-itp.pdf`.

[Gro21a]   Jason S. Gross. "Performance Engineering of Proof-Based Software Systems at Scale". PhD Thesis. Massachusetts Institute of Technology, Feb. 2021. URL: `https://jasongross.github.io/papers/2021-JGross-PhD-EECS-Feb2021.pdf`.

[Gro21b]   Jason Gross. *A Limited Case for Reification by Type Inference*. Presented at The Seventh International Workshop on Coq for Programming Languages (CoqPL'21). Jan. 2021. URL: `https://jasongross.github.io/papers/2021-reification-by-type-inference-coqpl.pdf`.

[Pit+20]   Clément Pit–Claudel, Peng Wang, Benjamin Delaware, Jason Gross, and Adam Chli-
           pala. "Extensible Extraction of Efficient Imperative Programs with Foreign Func-
           tions, Manually Managed Memory, and Proofs". In: *Proceedings of the 9th Interna-
           tional Joint Conference on Automated Reasoning (IJCAR'20)*. Ed. by Nicolas Peltier
           and Viorica Sofronie-Stokkermans. Paris, France: Springer International Publishing,
           June 2020, pp. 119–137. ISBN: 978-3-030-51054-1. DOI: `10.1007/978-3-030-51054-
           1_7`.

[Erb+19]   Andres Erbsen, Jade Philipoom, Jason Gross, Robert Sloan, and Adam Chlipala.
           "Simple High-Level Code For Cryptographic Arithmetic – With Proofs, Without
           Compromises". In: *Proceedings of the 40th IEEE Symposium on Security and Privacy
           (S&P'19)*. May 2019. DOI: `10.1145/3421473.3421477`. URL: `https://jasongross.
           github.io/papers/2019-fiat-crypto-ieee-sp.pdf`.

[Gro18]   Jason Gross. *Presentation Proposal for Teaching Your Rooster to Crow in C*. Pre-
           sented at The Coq Workshop 2018. July 2018. URL: `https://jasongross.github.
           io/presentations/coq-workshop-2018/coq-workshop-proposal-notations.
           pdf`.

[GEC18]   Jason Gross, Andres Erbsen, and Adam Chlipala. "Reification by Parametricity:
           Fast Setup for Proof by Reflection, in Two Lines of Ltac". In: *Proceedings of the 9th
           International Conference on Interactive Theorem Proving (ITP'18)*. Ed. by Jeremy
           Avigad and Assia Mahboubi. Cham: Springer International Publishing, July 2018,
           pp. 289–305. ISBN: 978-3-319-94821-8. DOI: `10.1007/978-3-319-94821-8_17`. URL:
           `https://jasongross.github.io/papers/2018-reification-by-parametricity-
           itp-camera-ready.pdf`.

[Chl+17]   Adam Chlipala, Benjamin Delaware, Samuel Duchovni, Jason Gross, Clément Pit–
           Claudel, Sorawit Suriyakarn, Peng Wang, and Katherine Ye. "The End of His-
           tory? Using a Proof Assistant to Replace Language Design with Library Design".
           In: *Proceedings of the The 2nd Summit oN Advances in Programming Languages
           (SNAPL'17)*. Ed. by Benjamin S. Lerner, Rastislav Bodík, and Shriram Krishna-
           murthi. Vol. 71. Leibniz International Proceedings in Informatics (LIPIcs). Asilo-
           mar, CA, USA: Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik, May 2017, 3:1–
           3:15. ISBN: 978-3-95977-032-3. DOI: `10.4230/LIPIcs.SNAPL.2017.3`. URL: `https:
           //jasongross.github.io/papers/FiatSNAPL17.pdf`.

[Bau+17]   Andrej Bauer, Jason Gross, Peter LeFanu Lumsdaine, Michael Shulman, Matthieu
           Sozeau, and Bas Spitters. "The HoTT Library: A Formalization of Homotopy Type
           Theory in Coq". In: *Proceedings of the 6th ACM SIGPLAN Conference on Certi-
           fied Programs and Proofs*. CPP 2017. Paris, France: ACM, Jan. 2017, pp. 164–172.
           ISBN: 978-1-4503-4705-1. DOI: `10.1145/3018610.3018615`. eprint: `1610.04591`. URL:
           `https://jasongross.github.io/papers/2017-HoTT-formalization.pdf`.

[Gro16]   Jason Gross. *The HoTT/HoTT Library in Coq: Designing for Speed*. Presented at
           The 5th International Congress on Mathematical Software (ICMS 2016). July 2016.
           URL: `https://jasongross.github.io/presentations/icms-2016/hott-hott-
           and-category-coq-experience.pdf`.

[Gro15a]   Jason Gross. "An Extensible Framework for Synthesizing Efficient, Verified Parsers".
           MA thesis. Massachusetts Institute of Technology, Sept. 2015. URL: `https://jasongross.
           github.io/papers/2015-jgross-thesis.pdf`.

[Del+15]   Ben Delaware, Clément Pit–Claudel, Jason Gross, and Adam Chlipala. "Fiat: De-
           ductive Synthesis of Abstract Data Types in a Proof Assistant". In: *Proceedings
           of the 42nd ACM SIGPLAN-SIGACT Symposium on Principles of Programming
           Languages (POPL'15)*. Jan. 2015. DOI: `10.1145/2775051.2677006`. URL: `https:
           //jasongross.github.io/papers/2015-adt-synthesis.pdf`.

[Gro15b]   Jason Gross. *Coq Bug Minimizer*. Presented at The First International Workshop on Coq for PL (CoqPL'15). Jan. 2015. URL: `https://jasongross.github.io/papers/2015-coq-bug-minimizer.pdf`.

[TG15]   Tobias Tebbi and Jason Gross. *A Profiler for Ltac*. Presented at The First International Workshop on Coq for PL (CoqPL'15). Jan. 2015. URL: `https://jasongross.github.io/papers/2015-ltac-profiler.pdf`.

[Gro14a]   Jason Gross. *Presentation: Input, Output, and Automation in x86 Proved*. Presented at Microsoft Research, Cambridge, UK. Aug. 2014. URL: `https://jasongross.github.io/presentations/msr-2014-final-talk/input-output-and-automation-in-x86proved.pdf`.

[GCS14]   Jason Gross, Adam Chlipala, and David I. Spivak. "Experience Implementing a Performant Category-Theory Library in Coq". In: *Proceedings of the 5th International Conference on Interactive Theorem Proving (ITP'14)*. Ed. by Gerwin Klein and Ruben Gamboa. Cham: Springer International Publishing, July 2014, pp. 275–291. ISBN: 978-3-319-08970-6. DOI: `10.1007/978-3-319-08970-6_18`. eprint: `1401.7694`. URL: `https://jasongross.github.io/papers/category-coq-experience-itp-submission-final.pdf`.

[Gro14b]   Jason Gross. *Presentation Proposal for Three Neat Tricks in Coq 8.5*. Presented at the 6th Coq Workshop. Apr. 2014. URL: `https://jasongross.github.io/presentations/coq-workshop-2014/coq-workshop-proposal-tactics-in-terms.pdf`.

[Gro14c]   Jason Gross. *Jason Gross' Wishlist for Coq*. Jan. 2014. URL: `https://jasongross.github.io/presentations/coq-8.6-wishlist/jgross-coq-8-6-wishlist-no-pause.pdf`.

[Gro14d]   Jason Gross. *POPL: Minute Madness: Category Theory in Coq, and Program Synthesis*. Presented at the 41st ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL'14). Jan. 2014. URL: `https://jasongross.github.io/presentations/popl-2014-minute-madness/jason-gross-minute-madness.pdf`.

[Gro13a]   Jason Gross. *CSAIL Student Workshop 2013: Computational Higher Inductive Types: Computing with Custom Equalities*. Presented at the 2014 MIT CSAIL Student Workshop. Oct. 2013. URL: `https://jasongross.github.io/presentations/csw-2013/jgross-presentation-no-pause.pdf`.

[Gro13b]   Jason Gross. *Building Database Management on top of Category Theory in Coq*. Presented as a student talk at the 40th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL'13). Jan. 2013. URL: `https://jasongross.github.io/presentations/popl-2013/jgross-student-talk.pdf`.

[Gro13c]   Jason Gross. *POPL: Minute Madness: Database Management on top of Category Theory in Coq: Category of Relational Schemas = Category of Categories*. Presented at the 40th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL'13). Jan. 2013. URL: `https://jasongross.github.io/presentations/popl-2013/minute-madness.pdf`.

[Lak+11]   Brenden M. Lake, Ruslan Salakhutdinov, Jason Gross, and Joshua B. Tenenbaum. "One shot learning of simple visual concepts". In: *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*. 2011. URL: `https://jasongross.github.io/papers/LakeEtAl2011CogSci.pdf`.