Curriculum Vitae

Clark Barrett

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Research Interests

Automated reasoning; satisfiability modulo theories (SMT); formal methods; formal verification; verification of smart contracts; verification of neural networks; AI safety; security; hardware design productivity and verification.

Education

Ph.D.: Stanford University, 2003, Computer Science. Advisor: David L. Dill.
Thesis Title: *Checking Validity of Quantifier-Free Formulas in Combinations of First-Order Theories.*

M.S.: Stanford University, 1998, Computer Science. Advisor: David L. Dill.

B.S.: Brigham Young University, 1995, Electrical and Computer Engineering (with Honors), Computer Science, and Mathematics. Summa Cum Laude with University Honors. Minors: Physics, Music.

Appointments

Professor (Research), Computer Science, Stanford University, Sept. 2021 to present.
Associate Professor (Research), Computer Science, Stanford University, Sept. 2016 to Aug. 2021.
Visiting Scientist, Google, Mountain View, CA, Jan. 2015 to July 2017.
Visiting Associate Professor, Stanford University, Sept. 2013 to Aug. 2016.
Associate Professor, Computer Science, Courant Institute, NYU, Sept. 2008 to Aug. 2016
Assistant Professor, Computer Science, Courant Institute, NYU, Sept. 2002 to 2008.

Research Group

Ph.D. Students: Alex Ozdemir, Scott Viteri, Amalee Wilson, Hanna Lachnitt, Rachel Cleaveland, Samuel Akinwande, Abdalrhman Mohamed, Leni Aniva, Chuyue Sun, Áron Ricardo Perez-Lopez, Elizaveta Pertseva, Daneshvar Amrollahi

Graduated Ph.D. Students:

- *Ying Sheng*, "Efficient Algorithms for Automated Reasoning and Large Language Models," Computer Science, Stanford University, 2024.
- *Haoze Wu*, "Bridging the Gap between Automated Logical Reasoning and Machine Learning," Computer Science, Stanford University, 2024.
- *Caleb Donovick*, "Enabling Agile Hardware Development with the PEak Programming Language," Computer Science, Stanford University, 2024.
- *Makai Mann*, "Augmenting Transition Systems for Scalable Symbolic Model Checking," Computer Science, Stanford University, 2021.
- *Andres Nötzli*, "Towards Better Simplifications in SMT Solvers with Applications in String Solving," Computer Science, Stanford University, 2021.

- *Kshitij Bansal*, "Decision Procedures for Finite Sets with Cardinality, and Local Theories Extensions," Computer Science, New York University, 2016.
- *Wei Wang*, "Partition Memory Models for Program Analysis," Computer Science, New York University, 2016.
- *Liana Hadarean*, "An Efficient and Trustworthy Theory Solver for Bit-vectors in Satisfiability Modulo Theories," Computer Science, New York University, 2014.
- *Tim King*, "Effective Algorithms for the Satisfiability of Quantifier-Free Formulas Over Linear Real and Integer Arithmetic," Computer Science, New York University, 2014.
- *Dejan Jovanović*, "SMT Beyond DPLL(T): A New Approach to Theory Solvers and Theory Combination," Computer Science, New York University, 2012.
- *Igor Chikanian*, "Automatic Deduction for Theories of Algebraic Data Types," Computer Science, New York University, 2011.
- *Chris Conway*, "Tools and Techniques for the Sound Verification of Low-Level Code," Computer Science, New York University, 2011.
- *Yeting Ge*, "Solving Quantified First Order Formulas in Satisfiability Modulo Theories," Computer Science, New York University, 2010.
- *Ying Hu*, "Translation Validation of Loop Optimizations," Computer Science, New York University, 2005.

Postdocs and Research Scientists:

- *Max Lamparth*, Postdoc, 2023 - present.
- *Pei Huang*, Postdoc, 2022 - present.
- *Min Wu*, Postdoc, 2022 - present.
- *Aina Niemetz*, Postdoc, 2017 - 2019; Research Scientist, 2019 - present.
- *Mathias Preiner*, Postdoc, 2017 - 2019; Research Scientist, 2019 - present.
- *Nestan Tsiskaridze*, Research Scientist, 2020 - present.
- *Florian Lonsing*, Research Scientist, 2019 - 2022.
- *Aleksandar Zeljić*, Postdoc, 2018 - 2022.
- *Gereon Kremer*, Postdoc, 2020 - 2022.
- *Yoni Zohar*, Postdoc, 2018 - 2021.
- *Ahmed Irfan*, Postdoc, 2019 - 2021.
- *Cristian Mattarei*, Postdoc, 2016 - 2018.
- *Guy Katz*, Postdoc, 2016 - 2018.
- *Morgan Deters*, Postdoc, 2008-2013; Senior Research Scientist, 2013-2015.
- *Dejan Jovanović*, Postdoc, 2012-2013.

Visiting Scholars:

- *Teruhiro Tagomori*, NRI Secure, 2020-present.
- *Stéphane Demri*, CNRS, 2012-2014.

Awards and Honors

Personal

CAV Award, 2024.
Best SCP Tool Paper, International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2022.
CAV Award, 2021.
Test of Time Award, Conference on Logic in Computer Science (LICS), 2021.
Honorable Mention Paper, Conference on Formal Methods in Computer-Aided Design (FMCAD), 2020.
Best Paper, International Joint Conference on Automated Reasoning (IJCAR), 2020.
Distinguished Artifact Award, International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2018.
Best Short Paper, Symposium on SDN Research, 2018.
Best Paper, Conference on Formal Methods in Computer-Aided Design (FMCAD), 2016.
Best Paper, International Test Conference (ITC), 2015.
ACM Distinguished Scientist, December 2014.
Haifa Verification Conference Award, October 2010.
Member, IFIP Working Group 2.3 (Programming Methodology), elected March, 2010.
IBM Software Quality Innovation Award, November 2008.
National Science Foundation CAREER award, 2007-2012.
Nominated for Miller Research Fellowship (declined), 2002.
Best Paper, Design Automation Conference (DAC), 1998.
National Science Foundation Graduate Fellowship (declined).
National Defense Science and Engineering Graduate Fellowship, 1995-1999.
Karl G. Maeser Graduate Fellowship, 1995.
Co-valedictorian, Brigham Young University, 1995.

Systems

SMT-COMP 2022: winner in 15 of 20 competition-wide categories (cvc5);
SMT-COMP 2021: winner in 17 of 20 competition-wide categories (cvc5);
SMT-COMP 2020: winner in 6 of 8 competition-wide categories (CVC4);
HWMCC 2019: winner (Cosa2)
SMT-COMP 2019: winner of 13 first place trophies (of 18 possible) (CVC4);
SyGuS-COMP 2019: winner, general, PBE-BV, PBE-Strings, Inv tracks (CVC4)
SMT-COMP 2018: winner, main track (CVC4);
SyGuS-COMP 2018: winner, general, PBE-BV, PBE-Strings, and CLIA (tied) tracks (CVC4)
SMT-COMP 2017: winner, main track (CVC4);
SyGuS-COMP 2017: winner, linear-integer-arithmetic track and strings track (CVC4)
SMT-COMP 2016: winner, main track (CVC4);
SyGuS-COMP 2016: winner, linear-integer-arithmetic track (CVC4)
CASC 2015: winner, TFN division (CVC4);
SMT-COMP 2015: winner, main track (CVC4);
SyGuS-COMP 2015: winner, general track and linear-integer-arithmetic track (CVC4);
SV-COMP 2015: bronze medal, MemorySafety division (Cascade);
CASC 2014: winner, TFA division (CVC4);
SMT-COMP 2014: winner, ALIA, AUFLIA, AUFLIRA, LIA, LRA, QF_AUFBV, QF_LRA, QF_NRA, UF, UFLIA divisions (CVC4);
SMT-COMP 2012: winner, QF_UFLRA division (CVC4);
SMT-COMP 2007: winner, AUFLIRA division (CVC3);
SMT-COMP 2006: winner, AUFLIRA division (CVC3);

Systems Under Development

cvc5: An open-source SMT solver. Available at
`http://cvc5.github.io`.

Pono: An SMT-based model checker. Available at

https://github.com/upscale-project/pono.

Smt-switch: A solver-agnostic API for SMT solving. Available at https://github.com/stanford-centaur/smt-switch.

Marabou: An open-source verifier for neural networks. Available at https://github.com/NeuralNetworkVerification/Marabou.

Previously Developed Systems

CVC4: An open-source SMT solver. Available at http://cvc4.stanford.edu/.

Cosa2: An open-source SMT-based model checker. Available at https://github.com/upscale-project/cosa2.

CoSA: An open-source hardware model-checker. Available at https://github.com/cristian-mattarei/CoSA

SMT Solvers: Stanford Validity Checker (SVC), Cooperating Validity Checker (CVC), CVC Lite, CVC3

Cascade: A program verification platform. Available at http://cvc4.cs.stanford.edu/cascade/.

TVOC: A Translation Validator for Optimizing Compilers. Available at http://cs.nyu.edu/acsys/tv.

Teaching

New York University

Computer Systems Organization, Fall 2012, Spring 2013.
Class web page available at http://cs.nyu.edu/web/Academic/Courses/archive.html.

Logic and Verification, Spring 2003, Spring 2004.
2003 class web page available at http://www.cs.nyu.edu/~barrett/courses/spr03/index.html. 2004 class web page available at http://cs.nyu.edu/courses/spring04/G22.3033-003/index.htm.

Logic in Computer Science, Fall 2003, Fall 2004, Fall 2007, Fall 2008, Fall 2009.
Class web pages available at http://cs.nyu.edu/web/Academic/Courses/archive.html.

Programming Languages, Fall 2008, Spring 2012.
Class web pages available at http://cs.nyu.edu/web/Academic/Courses/archive.html.

Software Engineering, Spring 2005, Spring 2006, Spring 2007, Spring 2008.
Class web pages available at http://cs.nyu.edu/web/Academic/Courses/archive.html.

Topics in Automated Deduction, Spring 2007, Spring 2009.
Class web pages available at http://cs.nyu.edu/web/Academic/Courses/archive.html.

Stanford University

Introduction to Automated Reasoning (CS 257), Fall 2022, Helped design course. Instructors: Caroline Trippel and Haoze Wu.

Advanced Computer Organization: Processor Architecture (EE 482), Teaching assistant, Spring 1997. Instructor: Kunle Olukotun.

Discrete Structures, Accelerated (CS 103X), Teaching assistant, Spring 2000, Winter 2001. Instructors: David Dill and John Mitchell.

Techniques for Program Analysis and Verification (CS 357), Co-instructor, Fall 2013, Fall 2015. Other instructors: Alex Aiken and David Dill.

Professional Activities

Steering Committee

FMCAD: Conference on Formal Methods in Computer-Aided Design, 2019-present.

SMT: International Workshop on Satisfiability Modulo Theories, 2009-2012, 2014-2018.

Program/Event Chair

Conference on Automated Deduction, PC co-chair, 2025.

AI Safety and Robustness in Finance Workshop, member of organizing committee, 2023.

Formal Verification of Machine Learning, Workshop at ICML, co-organizer, 2022.

FMCAD: International Conference on Formal Methods in Computer-Aided Design, co-chair, 2019.

VNN: AAAI Spring Symposium on Verification of Neural Networks, co-chair, 2019.

NASA Formal Methods Symposium, co-chair, 2017.

SAT/SMT Summer School, organizer, 2014; chair, 2015.

SMT-COMP: Satisfiability Modulo Theories Competition, co-chair, 2005, 2006, 2007, 2008, 2009, 2010.

Amir Pnueli Memorial Symposium, chair, 2010.

SMT: International Workshop on Satisfiability Modulo Theories, co-chair, 2008.

Program Committees

CADE: Conference on Automated Deduction, 2017, 2019.

CAV: International Conference on Computer Aided Verification, 2006, 2008, 2009, 2016, 2018, 2021.

CPP: Conference on Certified Programs and Proofs, 2017.

DIFTS: Workshop on Design and Implementation of Formal Tools and Systems, 2011.

FMCAD: International Conference on Formal Methods In Computer-Aided Design, 2006, 2020, 2023.

FoMLAS: Workshop on Formal Methods for ML-Enabled Autonomous Systems, 2019, 2020, 2021, 2022, 2023.

FroCoS: International Symposium on Frontiers of Combining Systems, 2005, 2011, 2013, 2015.

IJCAR: International Joint Conference on Automated Reasoning, 2018.

MEMOCODE: International Conference on Formal Methods and Models for Codesign, 2009.

NFM: NASA Formal Methods Symposium, 2016.

PAAR: Workshop on Practical Aspects of Automated Reasoning, 2012, 2014.

PDPAR: Workshop on Pragmatics of Decision Procedures in Automated Reasoning, 2003, 2004, 2005, 2006.

PXTP: Workshop on Proof eXchange for Theorem Proving, 2011.

SAIV: Symposium on AI Verification, 2024.

SAT: International Conference on Theory and Applications of Satisfiability Testing, 2005.

SBFM: Brazilian Symposium on Formal Methods, 2023.

SIGDA: Ph.D. Forum at the Design Automation Conference, 2004, 2005.

SMT: International Workshop on Satisfiability Modulo Theories, 2007, 2008, 2009, 2010, 2011, 2012, 2020, 2023, 2024.

SYNT: Workshop on Synthesis, 2021.

TPHOLs: International Conference on Theorem Proving and Higher Order Logics, 2004, 2005.

VMCAI: International Conference on Verification, Model Checking and Abstract Interpretation, 2008.

VSTTE: Workshop on Verified Software: Theories, Tools and Experiments, 2012.

WING: Workshop on Invariant Generation, 2012.

Referee

Conference/Workshop papers: CADE, CAV, DAC, EMSOFT, FMCAD, FroCoS, FSTTCS, IJCAR, LPAR, MEMOCODE, PAAR, PDPAR, POPL, SMT, TACAS, STACS, TPHOLs, VMCAI.

Journal papers: *ACM Computing Surveys*, *ACM Transactions on Computational Logic*, *AI Communications*, *Artificial Intelligence Journal*, *Communications of the ACM*, *Formal Aspects of Computing*, *Information and Computation*, *IEEE Transactions on Computer-Aided Design*, *Journal of Formal Methods in System Design*, *Journal of Automated Reasoning*, *Journal of the ACM*, *Journal on Satisfiability, Boolean Modeling and Computation*, *Journal of Symbolic Computation*, *Journal of Zhejiang University-Science A*, *Logical Methods in Computer Science*, *Science of Computer Programming*, *Theoretical Computer Science*.

Departmental Service (Stanford)

Awards committee, 2018-2021.
Gates space committee, 2017-2024.
Lecturer search committee, 2018-2019.
Masters program student advisor, 2016-2024.
PhD admissions, 2016-2018.
Strategic research initiatives committee (head), 2018-2024.

Departmental Service (NYU)

Appointments Committee, 2008-2009.
Coordinator for departmental spring showcase, 2007, 2008.
Department chair search committee, 2005-2006, 2008.
Director of Undergraduate Studies, 2009-2010.
Fellowship committee (PhD student admission and oversight committee), 2004-2008.

Graduate curriculum committee, 2006-2009.
Teaching load committee, 2006-2007.
Teaching assignments committee, 2009-2014.
Undergraduate curriculum committee, 2004-2010.
Undergraduate mentor, 2003-2008.

Other Activities

Participant at NSF workshops and panels.

One of three coordinators of the SMT-LIB initiative (see `http://www.smtlib.org`). Responsible for collecting and maintaining the library of benchmarks; chair of the SMT-LIB working group on model generation; contributor to many other aspects of the initiative.

Industry Experience

Consulting: Reservoir Labs Inc., Calypto Design Systems, MIT Lincoln Laboratory, Mentor Graphics (formerly 0-in Design Automation).

Amazon, 2023 - present. Amazon Scholar (Robert Jones, host). Consulting on uses and applications of automated reasoning tools.

Facebook Novi, 2018 - 2022. Consultant for Move Prover team (smart contract verification tool).

Google, 2015 - 2017, Visiting Scientist (Domagoj Babic, host). Using SMT to find security vulnerabilities.

Intel, 1996, Summer Intern under Carl Seger. Prototyping and development of an early version of *Forte*, a formal verification tool suite.

Microsoft Research, 1993, Summer Intern under Charles Simonyi. Programmer on "Intentional Programming" project.

Publications

Conference Publications

(1) Haoze Wu, Omri Isac, Aleksandar Zeljić, Teruhiro Tagomori, Matthew Daggitt, Wen Kokke, Idan Refaeli, Guy Amir, Kyle Julian, Shahaf Bassan, Pei Huang, Ori Lahav, Min Wu, Min Zhang, Ekaterina Komendantskaya, Guy Katz, and Clark Barrett. Marabou 2.0: A versatile formal analyzer of neural networks. In Arie Gurfinkel and Vijay Ganesh, editors, *Proceedings of the* 36^{th} *International Conference on Computer Aided Verification (CAV '24)*, volume 14681 of *Lecture Notes in Computer Science*, pages 249–264. Springer, July 2024. Montreal, Canada.

(2) Alex Ozdemir, Shankara Pailoor, Alp Bassa, Kostas Ferles, Clark Barrett, and Işil Dillig. Split gröbner bases for satisfiability modulo finite fields. In Arie Gurfinkel and Vijay Ganesh, editors, *Proceedings of the* 36^{th} *International Conference on Computer Aided Verification (CAV '24)*, volume 14681 of *Lecture Notes in Computer Science*, pages 3–25. Springer, July 2024. Montreal, Canada.

(3) Nestan Tsiskaridze, Clark Barrett, and Cesare Tinelli. Generalized optimization modulo theories. In Christoph Benzmüller and Marijn J.H. Heule, editors, *Proceedings of the* 12^{th} *International Joint Conference on Automated Reasoning (IJCAR '24)*, volume 14739 of *Lecture Notes in Computer Science*, pages 458–479. Springer, July 2024. Nancy, France.

(4) Haoze Wu, Clark Barrett, and Nina Narodytska. Lemur: Integrating large language models in automated program verification. In *The Twelfth International Conference on Learning Representations (ICLR '24)*, May 2024. Vienna, Austria.

(5) Hanna Lachnitt, Mathias Fleury, Leni Aniva, Andrew Reynolds, Haniel Barbosa, Andres Nötzli, Clark Barrett, and Cesare Tinelli. IsaRare: Automatic verification of SMT rewrites in Isabelle/HOL. In Bernd Finkbeiner and Laura Kovács, editors, *Proceedings of the* 30^{th} *International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS '24)*, volume 14570 of *Lecture Notes in Computer Science*, pages 311–330. Springer, apr 2024. Luxembourg City, Luxembourg.

(6) Pei Huang, Haoze Wu, Yuting Yang, Ieva Daukantas, Min Wu, Yedi Zhang, and Clark Barrett. Towards efficient verification of quantized neural networks. In *Proceedings of the AAAI Conference on Artificial Intelligence (AAAI-24)*, volume 38, pages 21152–21160, February 2024. Vancouver, Canada.

(7) Min Wu, Haoze Wu, and Clark Barrett. Verix: Towards verified explainability of deep neural networks. In A. Oh, T. Neumann, A. Globerson, K. Saenko, M. Hardt, and S. Levine, editors, *Advances in Neural Information Processing Systems 36 (NeurIPS 2023)*, volume 36, pages 22247–22268. Curran Associates, Inc., December 2023.

(8) Zhenyu Zhang, Ying Sheng, Tianyi Zhou, Tianlong Chen, Lianmin Zheng, Ruisi Cai, Zhao Song, Yuandong Tian, Christopher Ré, Clark Barrett, Zhangyang "Atlas" Wang, and Beidi Chen. H_2o: Heavy-hitter oracle for efficient generative inference of large language models. In A. Oh, T. Neumann, A. Globerson, K. Saenko, M. Hardt, and S. Levine, editors, *Advances in Neural Information Processing Systems 36 (NeurIPS 2023)*, volume 36, pages 34661–34710. Curran Associates, Inc., December 2023.

(9) Banghua Zhu, Ying Sheng, Lianmin Zheng, Clark Barrett, Michael Jordan, and Jiantao Jiao. Towards optimal caching and model selection for large model inference. In A. Oh, T. Neumann, A. Globerson, K. Saenko, M. Hardt, and S. Levine, editors, *Advances in Neural Information Processing Systems 36 (NeurIPS 2023)*, volume 36, pages 59062–59094. Curran Associates, Inc., December 2023.

(10) Abdalrhman Mohamed, Andrew Reynolds, Clark Barrett, and Cesare Tinelli. A procedure for sygus solution fitting via matching and rewrite rule discovery. In Alexander Nadel and Kristin Yvonne Rozier, editors, *Proceedings of the* 23^{rd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '23)*, pages 189–198. TU Wien Academic Press, October 2023. Ames, IA.

(11) Haoze Wu, Christopher Hahn, Florian Matthias Lonsing, Makai Mann, Raghuram Ramanujan, and Clark Barrett. Lightweight online learning for sets of related problems in automated reasoning. In Alexander Nadel and Kristin Yvonne Rozier, editors, *Proceedings of the* 23^{rd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '23)*, pages 23–33. TU Wien Academic Press, October 2023. Ames, IA.

(12) Amalee Wilson, Andres Nötzli, Andrew Reynolds, Byron Cook, Cesare Tinelli, and Clark Barrett. Partitioning strategies for distributed SMT solving. In Alexander Nadel and Kristin Yvonne Rozier, editors, *Proceedings of the* 23^{rd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '23)*, pages 199–208. TU Wien Academic Press, October 2023. Ames, IA.

(13) Guilherme V. Toledo, Yoni Zohar, and Clark Barrett. Combining finite combination properties: Finite models and busy beavers. In Uri Sattler and Martin Suda, editors, *Proceedings of the* 14^{th} *International Symposium on Frontiers of Combining Systems (FroCoS '23)*, volume 14279 of *Lecture Notes in Artificial Intelligence*, pages 159–175. Springer, September 2023. Prague, Czech Republic.

(14) Burak Ekici, Arjun Viswanathan, Yoni Zohar, Cesare Tinelli, and Clark Barrett. Formal verification of bit-vector invertibility conditions in coq. In Uri Sattler and Martin Suda, editors, *Proceedings of the* 14^{th} *International Symposium on Frontiers of Combining Systems (FroCoS '23)*, volume 14279 of *Lecture Notes in Artificial Intelligence*, pages 41–59. Springer, September 2023. Prague, Czech Republic.

(15) Saranyu Chattopadhyay, Keerthikumara Devarajegowda, Bihan Zhao, Florian Lonsing, Brandon A. D'Agostino, Ioanna Vavelidou, Vijay D. Bhatt, Sebastian Prebeck, Wolfgang Ecker, Caroline Trippel, Clark Barrett, and Subhasish Mitra. G-QED: Generalized QED pre-silicon verification beyond non-interfering hardware accelerators. In *Proceedings of the* 60^{th} *Design Automation Conference (DAC '23)*. IEEE, July 2023. San Francisco, CA.

(16) Jackson Melchert, Kathleen Feng, Caleb Donovick, Ross Daly, Ritvik Sharma, Clark Barrett, Mark A. Horowitz, Pat Hanrahan, and Priyanka Raina. APEX: A framework for automated processing element design space exploration using frequent subgraph analysis. In *Proceedings of the* 28^{th} *ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), Volume 3*, ASPLOS 2023, pages 33–45, New York, NY, USA, March 2023. Association for Computing Machinery. Vancouver, BC, Canada.

(17) Omri Isac, Yoni Zohar, Clark Barrett, and Guy Katz. DNN verification, reachability, and the exponential function problem. In Guillermo A. Pérez and Jean-François Raskin, editors, 34^{th} *International Conference on Concurrency Theory (CONCUR '23)*, volume 279 of *Leibniz International Proceedings in Informatics (LIPIcs)*, pages 26:1–26:18, Dagstuhl, Germany, September 2023. Schloss Dagstuhl – Leibniz-Zentrum für Informatik. Antwerp, Belgium.

(18) Alex Ozdemir, Riad S. Wahby, Fraser Brown, and Clark Barrett. Bounded verification for finite-field-blasting. In Constantin Enea and Akash Lal, editors, *Proceedings of the* 35^{th} *International Conference on Computer Aided Verification (CAV '23)*, volume 13965 of *Lecture Notes in Computer Science*, pages 154–175. Springer, July 2023. Paris, France.

(19) Alex Ozdemir, Gereon Kremer, Cesare Tinelli, and Clark Barrett. Satisfiability modulo finite fields. In Constantin Enea and Akash Lal, editors, *Proceedings of the* 35^{th} *International Conference on Computer Aided Verification (CAV '23)*, volume 13965 of *Lecture Notes in Computer Science*, pages 163–186. Springer, July 2023. Paris, France.

(20) Guilherme V. Toledo, Yoni Zohar, and Clark Barrett. Combining combination properties: An analysis of stable infiniteness, convexity, and politeness. In Brigitte Pientka and Cesare Tinelli, editors, *Proceedings of the* 29^{th} *International Conference on Automated Deduction (CADE '23)*, volume 14132 of *Lecture Notes in Artificial Intelligence*, pages 522–541. Springer, July 2023. Rome, Italy.

(21) Dennis Wei, Haoze Wu, Min Wu, Pin-Yu Chen, Clark Barrett, and Eitan Farchi. Convex bounds on the softmax function with applications to robustness verification. In Francisco Ruiz, Jennifer Dy, and Jan-Willem van de Meent, editors, *Proceedings of The* 26^{th} *International Conference*

on Artificial Intelligence and Statistics (AISTATS '23), volume 206 of *Proceedings of Machine Learning Research*, pages 6853–6878. PMLR, April 2023. Valencia, Spain.

(22) Elazar Cohen, Yizhak Yisrael Elboher, Clark Barrett, and Guy Katz. Tighter abstract queries in neural network verification. In Ruzica Piskac and Andrei Voronkov, editors, *Proceedings of* 24^{th} *International Conference on Logic for Programming, Artificial Intelligence and Reasoning (LPAR '23)*, volume 94 of *EPiC Series in Computing*, pages 124–143. EasyChair, March 2023. Manizales, Columbia.

(23) Haniel Barbosa, Chantal Keller, Andrew Reynolds, Arjun Viswanathan, Cesare Tinelli, and Clark Barrett. An interactive smt tactic in coq using abductive reasoning. In Ruzica Piskac and Andrei Voronkov, editors, *Proceedings of* 24^{th} *International Conference on Logic for Programming, Artificial Intelligence and Reasoning (LPAR '23)*, volume 94 of *EPiC Series in Computing*, pages 11–22. EasyChair, March 2023. Manizales, Columbia.

(24) Haoze Wu, Teruhiro Tagomori, Alexander Robey, Fengjun Yang, Nikolai Matni, George Pappas, Hamed Hassani, Corina Păsăreanu, and Clark Barrett. Toward certified robustness against real-world distribution shifts. In Patrick McDaniel and Nicolas Papernot, editors, *Proceedings of the 2023 IEEE Conference on Secure and Trustworthy Machine Learning (SaTML)*, pages 537–553. IEEE, February 2023. Raleigh, NC.

(25) Matan Ostrovsky, Clark Barrett, and Guy Katz. An abstraction-refinement approach to verifying convolutional neural networks. In Ahmed Bouajjani, Lukáš Holík, and Zhilin Wu, editors, *Proceedings of the* 20^{th} *International Symposium on Automated Technology for Verification and Analysis (ATVA '22)*, volume 13505 of *Lecture Notes in Computer Science*, pages 391–396. Springer International Publishing, October 2022.

(26) Ross Daly, Caleb Donovick, Jackson Melchert, Rajsekhar Setaluri, Nestan Tsiskaridze, Priyanka Raina, Clark Barrett, and Pat Hanrahan. Synthesizing instruction selection rewrite rules from RTL using SMT. In Alberto Griggio and Neha Rungta, editors, *Proceedings of the* 22^{nd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '22)*, pages 139–150. TU Wien Academic Press, October 2022.

(27) Andres Nötzli, Haniel Barbosa, Aina Niemetz, Mathias Preiner, Andrew Reynolds, Clark Barrett, and Cesare Tinelli. Reconstructing fine-grained proofs of rewrites using a domain-specific language. In Alberto Griggio and Neha Rungta, editors, *Proceedings of the* 22^{nd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '22)*, pages 65–74. TU Wien Academic Press, October 2022.

(28) Abhishek Nair, Saranyu Chattopadhyay, Haoze Wu, Alex Ozdemir, and Clark Barrett. Proof-stitch: Proof combination for divide-and-conquer SAT solvers. In Alberto Griggio and Neha Rungta, editors, *Proceedings of the* 22^{nd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '22)*, pages 84–88. TU Wien Academic Press, October 2022.

(29) Tom Zelazny, Haoze Wu, Clark Barrett, and Guy Katz. On optimizing back-substitution methods for neural network verification. In Alberto Griggio and Neha Rungta, editors, *Proceedings of the* 22^{nd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '22)*, pages 17–26. TU Wien Academic Press, October 2022.

(30) Omri Isac, Clark Barrett, Min Zhang, and Guy Katz. Neural network verification with proof production. In Alberto Griggio and Neha Rungta, editors, *Proceedings of the* 22^{nd} *International Conference on Formal Methods In Computer-Aided Design (FMCAD '22)*, pages 38–48. TU Wien Academic Press, October 2022.

(31) Ying Sheng, Andres Nötzli, Andrew Reynolds, Yoni Zohar, David Dill, Wolfgang Grieskamp, Junkil Park, Shaz Qadeer, Clark Barrett, and Cesare Tinelli. Reasoning about vectors using an smt theory of sequences. In Jasmin Blanchette, Laura Kovács, and Dirk Pattinson, editors, *Proceedings of the* 11^{th} *International Joint Conference on Automated Reasoning (IJCAR '22)*, volume 13385 of *Lecture Notes in Computer Science*, pages 125–143. Springer Nature, August 2022.

(32) Gereon Kremer, Andrew Reynolds, Clark Barrett, and Cesare Tinelli. Cooperating techniques for solving nonlinear real arithmetic in the cvc5 smt solver (system description). In Jasmin Blanchette,

Laura Kovács, and Dirk Pattinson, editors, *Proceedings of the* 11^{th} *International Joint Conference on Automated Reasoning (IJCAR '22)*, volume 13385 of *Lecture Notes in Computer Science*, pages 95–105. Springer Nature, August 2022.

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"Towards Verification of Deep Neural Networks," IFIP Working Group 2.3, Los Altos, CA, October 31, 2019.

"Challenges and Opportunities in Formal Methods," Formal Methods at Scale (invitation-only NSA/DoD meeting), SRI, Menlo Park, CA, October 9, 2019.

"Upscale: Scaling up Verification for Open Source Hardware," Defense Advanced Research Projects Agency Electronics Resurgence Initiative Summit, Detroit, MI, July 16, 2019.

"Verification of Deep Neural Networks with SMT," Online Briefing for the Aerospace Vehicle Systems Institute Working Group on Machine Learning, November 13, 2018.

"Formal Methods for AI Safety," GE Edge & Controls Symposium, GE Global Research Center, Niskayuna, NY, September 27, 2018.

"Verification of Deep Neural Networks with SMT," Apple Computer Town Hall, Cupertino, CA, August 20, 2018.

"Breaking Barriers in Formal Hardware Verification," Defense Advanced Research Projects Agency Electronics Resurgence Initiative Summit, San Francisco, CA, July 24, 2018.

"Verification of Deep Neural Networks with SMT," Tutorial at the Design Automation Conference (DAC), San Francisco, CA, June 27, 2018.

"Towards Formally Verified Deep Neural Networks," High Confidence Software and Systems Conference, Annapolis, MD, May 7, 2018.

"Formal Methods for Safe Autonomy," Workshop on The Road to Safe Autonomy, Stanford, CA, April 18, 2018.

"Towards Verification of Deep Neural Networks," NeurIPS Workshop on Machine Learning and Computer Security, Los Angeles, CA, December 8, 2017.

"Dramatic Improvements in Pre-silicon and Post-silicon Validation of Digital Systems with Quick Error Detection and Formal Methods," USC Computer Engineering Seminar, Los Angeles, CA, September 21, 2017.

"20 Years of Decision Procedures," Dill@60 Workshop, Heidelberg, Germany, July 24, 2017.

"Formal Verification of Deep Neural Networks," SystemX Workshop, Stanford, CA, April 12, 2017.

"Automatic Discovery and Localization of Tough Bugs in Large SoCs using Formal-Enhanced Quick Error Detection," DREAM Seminar, Berkeley, CA, March 6, 2017.

"Reluplex: An Efficient SMT Solver for Verifying Deep Neural Networks," Google Brain Seminar, Mountain View, CA, February 24, 2017.

"Electrical Bug Localization with Quick Error Detection Enhanced by Formal Methods," SystemX Conference, Stanford, CA, November 15, 2016.

"Satisfiability Modulo Theories," Sixth Summer School on Formal Techniques, Menlo College, Menlo Park, CA, May 23, 2016.

"Satisfiability Modulo Theories," SRI, Menlo Park, CA, November 10, 2015; Stanford University, Stanford, CA, November 11, 2015.

"The Satisfiability Revolution and the Rise of SMT," Google, New York, NY, December 9, 2014; Samsung Research America, San Jose, CA, October 7, 2014; NASA Ames, Moffett Field, CA, August 14, 2015; UC Davis, Davis, CA, May 29, 2014.

"Satisfiability Modulo Theories," Ed Clarke Symposium, Carnegie Mellon University, Pittsburg, PA, September 19, 2014.

"Proofs in Satisfiability Modulo Theories," with Pascal Fontaine and Leonardo de Moura, All about Proofs, Proofs for All, Vienna, Austria, July 18, 2014.

"SMT: Where do we go from here?" 12^{th} International Workshop on Satisfiability Modulo Theories, Vienna, Austria, July 17, 2014.

"Lazy and Eager Approaches to Solving Bit-vectors," SRC GRC CADTS Verification Review, Austin, TX, April 15, 2014.

"The Satisfiability Revolution and the Rise of SMT," ExCape Webinar, March 3, 2014, online at `https://excape.cis.upenn.edu/news-events.html`.

"Lazy Bit-Vector Solving using Subtheories," SRC GRC CADTS Verification Review, Berkeley, CA, April 10, 2013.

"Bit-Precise Reasoning in Systems Analysis and Verification," Yale University, New Haven, CT, February 14, 2013.

"The Satisfiability Revolution and the Rise of the Ingenious Machine," Stanford University, Stanford, CA, January 10, 2013.

"Scalable and Accurate SMT-based Model Checking of Data Flow Systems," AFOSR Annual Review, Washington, DC, November 27, 2012.

"Beyond DPLL(T): A New Model-Based Approach to Search in SMT and its Application to Solving Nonlinear Arithmetic," Carnegie Mellon University, Pittsburgh, PA, October 5, 2012.

"From SAT to SMT: Successes and Challenges," Harvard University, Cambridge, MA, August 19, 2012.

"New Insights on the Nelson-Oppen Method," Northeastern University, Boston, MA, August 13, 2012.

"Beyond DPLL(T): A New Boolean Search Framework for Model-Based Theory Reasoning," IFIP Working Group 2.3, Seattle, WA, July 18, 2012.

"Efficient SMT Solving for Bit-vectors and Arrays," SRC GRC CADTS Verification Review, Boulder, CO, April 11, 2012.

"Scalable and Accurate SMT-based Model Checking of Data Flow Systems," AFOSR Annual Review, Arlington, VA, October 26, 2011.

"From SVC to CVC4: 15 Years of Decision Procedures," SMT Summer School, MIT, Cambridge, MA, June 13, 2011.

"An Abstract Decision Procedure for a Theory of Bit-Vectors," SRC GRC CADTS Verification Review, Santa Barbara, CA, April 6, 2011.

"Tools and Techniques for the Sound Verification of Low-Level Code," MIT, Cambridge, MA, March 31, 2011.

"Sharing is Caring: An Efficient New Theory Combination Method," SRC GRC CADTS Verification Review, Austin, Texas, April 13, 2010.

"New Insights on the Nelson-Oppen Method," IFIP Working Group 2.3, Lachen, Switzerland, March 2, 2010.

"An Introduction to Satisfiability Modulo Theories," Tutorial (with Sanjit Seshia) at the International Conference on Computer-Aided Design (ICCAD), San Jose, CA, November 2, 2009.

"From SAT to SMT: Successes and Challenges," Keynote address at the Eighth International Workshop On The ACL2 Theorem Prover and Its Applications, Northeastern University, Boston, MA, May 12, 2009.

"Improving Bit-Vector Reasoning in Satisfiability Modulo Theories," SRC GRC CADTS Verification Review, Raleigh, NC, April 15, 2009.

"Satisfiability Modulo Theories: Successes and Challenges," NSF Workshop on Symbolic Computation for Constraint Satisfaction, Arlington, VA, November 14, 2008.

"Satisfiability Modulo Theories," MIT, Cambridge, MA, September 25, 2008.

"SAT Solvers: Theory and Practice," and "SMT Solvers: Theory and Practice," invited lectures at the Summer School on Verification Technology, Systems & Applications, Max-Planck-Institut für Informatik, Saarbrücken, Germany, September 15-19, 2008.

"SAT and SMT Solvers: Theory and Practice," MIT Lincoln Laboratory, Lincoln, MA, September 5, 2008.

"Bit-Precise Reasoning Using Satisfiability Modulo Theories," IFIP Working Group 2.3, Cambridge, UK, July 23, 2008.

"Satisfiability Modulo Theories," IBM T. J. Watson Research Center, Hawthorne, New York, May 19, 2008.

"Satisfiability Modulo Theories," UT Austin, April 18, 2008.

"Satisfiability Modulo Theories," IFIP Working Group 2.3, Santa Fe, NM, October 11, 2007.

"Satisfiability Modulo Theories in Practice," CMU, Pittsburgh, PA, April 16, 2007.

"An Abstract Decision Procedure for Satisfiability in the Theory of Recursive Data Types," Microsoft Research, Redmond, Washington, November 6, 2006.

"Satisfiability Modulo Theories," Reservoir Labs, New York, New York, October 20, 2006.

"Formal Software Verification," Cooper Union, New York, New York, October 19, 2006.

"CASCADE: C Assertion Checker and Deductive Engine," IBM T. J. Watson Research Center, Hawthorne, New York, August 31, 2006.

"Compiler Validation with Automated Decision Procedures," University of Iowa, Iowa City, Iowa, November 11, 2005.

"DPLL(T) with Generalized Theory Propagation," Workshop on Deduction and Applications, Schloß DagStuhl, October 28, 2005.

"Satisfiability Modulo Theories," Princeton University, Princeton, New Jersey, October 5, 2005.

"Theory and Practice of Decision Procedures for Combinations of Theories," invited tutorial presented with Cesare Tinelli at the 17^{th} International Conference on Computer Aided Verification (CAV '05), Edinburgh, Scotland, July 6, 2005.

"Compiler Validation using Automated Decision Procedures," Microsoft Research, Redmond, Washington, December 16, 2004.

"Compiler Validation with Automated Decision Procedures," Reservoir Labs Technical Presentation, Reservoir Labs, New York, New York, November 29, 2004; Bioinformatics Lab Talk, New York University, New York, New York, November 24, 2004; Computer Science Invited Lecture Series, Pace University, New York, New York, October 26, 2004.

"CVC Lite: Selected Stories from the Trenches," Combination of Decision Procedures Summer School, SRI International, Menlo Park, California, August 11, 2004.

"Using Proofs for Fast and Reliable Boolean Reasoning in CVC Lite," Intel Formal Verification Symposium, Hillsboro, Oregon, June 11, 2004.

"The Common Roots of Mathematics and Computing," Faculty Resource Network, New York University, New York, New York, June 8, 2004.

"Formal Software Verification," Pace University, New York, New York, March 22, 2004.

"Applying Automated Decision Procedures: Using CVC Lite in Compiler Validation," Computer Science Colloquium, Washington University, St. Louis, Missouri, September 12, 2003.

"Efficiently Combining Boolean and First-Order Reasoning," Max Planck Institut für Informatik, Saarbrücken, Germany, June 10, 2003.

"The Nelson-Oppen Method for Combining Decision Procedures," Max Planck Institut für Informatik, Saarbrücken, Germany, June 5, 2003.

"Checking Validity of Quantifier-Free Formulas in Combinations of First-Order Theories," Rice University, April 2002; University of Pisa, April 2002; California Institute of Technology, March 2002; Northrop Grumman, March 2002; NEC Laboratories, March 2002; New York University, March 2002; University of Utah, March 2002; Columbia University, March 2002; Brigham Young University, February 2002.

"A Framework for Cooperating Decision Procedures," Intel Strategic CAD Laboratories, Hillsboro, Oregon, May 2000.

"A Unified Framework for Cooperating Decision Procedures," Brigham Young University Computer Science Colloquium, Provo, Utah, March 2000.

"Bit-Vector Decision Procedures in the Stanford Validity Checker," SRI International, Menlo Park, California, May 1998.