Curriculum Vitae

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Experience and Job History

01/2013–present	Principal Researcher at Microsoft, Redmond, WA, USA
01/2010–01/2013	Senior Researcher at Microsoft, Redmond, WA, USA
08/2006–01/2010	Researcher at Microsoft, Redmond, WA, USA
02/2001–08/2006	Computer Scientist at SRI International, Menlo Park, CA, USA
04/2000–12/2000	Computer Engineer at Advus, São Paulo, Brazil
08/1994–04/2000	Research Assistant at the Software Engineering Laboratory of PUC-Rio
06/1998–12/1998	Visiting Researcher at Semantic Designs, Austin, TX, USA

Education

04/2000	Ph.D. in Computer Science, Thesis topic: "Automating the Generation of Program Analysis and Verification Tools" Advisor: Carlos José Pereira de Lucena Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil
03/1996	M.Sc. in Computer Science, Thesis topic: "Visual Development Environments" Advisor: Carlos José Pereira de Lucena Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil
01/1994	Computer Engineer, Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil

Research Interests

Decision Procedures, Theorem Proving, Model Checkers, Static Analysis, System Verification.

Awards

04/2018–	ETAPS 2018 Test of Time Award for the paper *Z3: An Efficient SMT Solver*
08/2017–	Skolem Award for the paper *Efficient E-Matching for SMT Solvers*. The Skolem award is given to the papers that have passed the test of time by being a most influential in the field of automated deduction.
06/2015–	Programming Languages Software Award for Z3 from ACM SIGPLAN.
04/2014–	TACAS Conference Award. Most influential tool paper in the first 20 years of TACAS.
08/2010–	Haifa Verification Conference Award. The HVC award is given to the most influential work in the last five years in the scope of software and hardware verification and testing.
12/2007–	Microsoft Gold Star (for the Z3 theorem prover) Microsoft
07/2005–	SRI Focus Award (Outstanding Employee) SRI International
03/2000–	Second Prize in the ACM'2000 Student Research Contest Association of Computing Machinery (ACM)
03/1996– 03/2000	Doctorate Fellowship Brazilian Council for Science and Technology (CNPq)
02/1994– 03/1996	M.Sc. Fellowship Brazilian Council for Science and Technology (CNPq)
08/1989– 10/1992	Undergraduate Fellowship, Brazilian Council for Science and Technology (CNPq)

Publications

1. D. Selsam, M. Lamm, B. Bnz, P. Liang, L. de Moura and D. Dill, *Learning a SAT Solver from Single-Bit Supervision*, International Conference on Learning Representations (ICLR), 2019.

2. G. Ebner, S. Ullrich, J. Roesch, J. Avigad and L. de Moura, *A Metaprogramming Framework for Formal Verification*, Proc. ACM Program. Lang., ICFP, August 2017.

3. D. Selsam and L. de Moura, *Congruence Closure in Intensional Type Theory*, 8th International Joint Conference in Automated Reasoning (IJCAR), 2016.

4. R. Lewis and L. de Moura, *Automation and Computation in the Lean Theorem Prover*, International Conference on Artificial Intelligence and Theorem Proving (AITP), 2016

5. J. Avigad, L. de Moura and S. Kong. *Theorem Proving in Lean*, 2015.

6. L. de Moura, S. Kong, J. Avigad, F. van Doorn and J. von Raumer, *The Lean Theorem Prover*, 25th International Conference on Automated Deduction, 2015.

7. C. Barrett, L. de Moura and P. Fontaine, *Proofs in Satisfiability Modulo Theories*, Mathematical Logic and Foundations. College Publications, London, UK, 2015.

8. A. Reynolds, C. Tinelli and L. de Moura, *Finding Conflicting Instances of Quantified Formulas in SMT*, 14th International Conference on Formal Methods in Computer-Aided Design, 2014.

9. D. Jovanović, C. Barrett, and L. de Moura, *The design and implementation of the model constructing satisfiability calculus*, 13th International Conference on Formal Methods in Computer-Aided Design, 2013.

10. L. de Moura and G. O. Passmore, *Computation in real closed infinitesimal and transcendental extensions of the rationals*, 24th International Conference on Automated Deduction, 2013.

11. L. de Moura and G. O. Passmore, *The Strategy Challenge in SMT Solving*, Automated Reasoning and Mathematics: Essays in Memory of William W. McCune, LNAI 7788, 2013.

12. L. de Moura, D. Jovanović, *A Model-Constructing Satisfiability Calculus*, 14th International Conference on Verification, Model Checking, and Abstract Interpretation (VMCAI) 2013.

13. D. Jovanović and L. de Moura, *Cutting to the chase solving linear integer arithmetic*, Journal of Automated Reasoning, 2013 (*submitted*).

14. G. Passmore, L. C. Paulson, L. de Moura, *Real algebraic strategies for MetiTarski proofs*, 11th International Conference, AISC 2012, 19th Symposium, Calculemus 2012.

15. D. Jovanović, L. de Moura, *Solving nonlinear arithmetic*, 6th International Joint Conference in Automated Reasoning (IJCAR) 2012.

16. D. Jovanović, L. de Moura, *Solving nonlinear arithmetic*, Technical Report MSR-TR-2012-20, Microsoft Research, 2012.

17. C. Barrett, M. Deters, L. de Moura, A. Oliveras, and A. Stump, *6 Years of SMT-COMP*, Journal of Automated Reasoning, 2012.

18. N. Bjorner, and L. de Moura, *Tractability and Modern Satisfiability Modulo Theories Solvers*, Handbook of Tractability, Cambridge University Press, 2012.

19. K. Hoder, N. Bjorner, and L. de Moura, *muZ - an efficient engine for fixed points with constraints*, Computer Aided Verification (CAV) 2011.

20. L. de Moura and N. Bjorner, *Satisfiability modulo theories: introduction and applications*, Communications of the ACM, (CACM) 2011.

21. D. Jovanović and L. de Moura, *Cutting to the chase solving linear integer arithmetic*, 23rd International Conference on Automated Deduction (CADE), 2011.

22. M. P. Bonacina, C. Lynch, and L. de Moura, *On deciding satisfiability by theorem proving with speculative inferences*, Journal of Automated Reasoning, 2011.

23. M. Veanes, N. Bjorner and L. de Moura, *Symbolic Automata Constraint Solving*, International Conference on Logic programming and automated reasoning (LPAR), 2010.

24. C. Wintersteiger, Y. Hamadi and L. de Moura, *Efficiently Solving Quantified Bit-Vector Formula*, International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2010.

25. L. de Moura and N. Bjorner, *Bugs, Moles and Skeletons: Symbolic Reasoning for Software Development*, International Joint Conference on Automated Reasoning (IJCAR), 2010.

26. N. Bjorner and L. de Moura, *TAPAS Theory Combinations and Practical Applications*, invited paper at FORMATS 2009.

27. L. de Moura and N. Bjorner, *Generalized and Efficient Array Decision Procedures*, International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2009.

28. L. de Moura and N. Bjorner, *Satisfiability Modulo Theories: An Appetizer*, invited paper to SBMF 2009.

29. G. O. Passmore and L. de Moura, *Superfluous S-polynomials in Strategy-Independent Grobner Bases*, 11th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), 2009.

30. L. de Moura and G. O. Passmore, *On Locally Minimal Nullstellensatz Proofs*, International Workshop on Satisfiability Modulo Theories (SMT), 2009.

31. G. O. Passmore and L. de Moura, *Universality of Polynomial Positivity and a Variant of Hilbert's 17th Problem*, ADDCT'09.

32. L. de Moura and N. Bjorner, *$Z3^{10}$: Applications, Enablers, Challenges and Directions*, invited paper to CFV 2009.

33. M. P. Bonacina, C. Lynch and L. de Moura, *On deciding satisfiability by DPLL(Gamma+T) and unsound theorem proving*, 22nd International Conference on Automated Deduction (CADE-22), 2009.

34. Y. Ge and L. de Moura, *Complete instantiation for quantified SMT formulas*, International Conference on Computer Aided Verification (CAV 2009).

35. C. Wintersteiger, Y. Hamadi and L. de Moura, *A Concurrent Portfolio Approach to SMT Solving*, International Conference on Computer Aided Verification (CAV 2009).

36. R. Piskac, L. de Moura and N. Bjorner, *Deciding Effectively Propositional Logic with Equality* Technical Report: MSR-TR-2008-181.

37. N. Bjorner, B. Dutertre and L. de Moura *Accelerating Lemma Learning using Joins - DPPL(Join)*, International Conference on Logic programming and automated reasoning (LPAR), 2008.

38. L. de Moura and N. Bjorner, *Proofs and Refutations, and Z3*, IWIL 2008.

39. N. Bjorner, L. de Moura and N. Tillmann, *Satisfiability Modulo Bit-precise Theories for Program Exploration*, Invited workshop paper, CFV 2008.

40. L. de Moura and N. Bjorner, *Deciding Effectively Propositional Logic using DPLL and substitution sets*, International Joint Conference on Automated Reasoning (IJCAR), 2008.

41. L. de Moura, N. Bjorner, *Engineering DPLL(T) + Saturation*, International Joint Conference on Automated Reasoning (IJCAR), Sydney, Australia, 2008.

42. L. de Moura and N. Bjorner, *Z3: An Efficient SMT Solver*, International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2008.

43. L. de Moura and N. Bjorner, *Relevancy Propagation*, MSR Technical Note, 2007.

44. L. de Moura and N. Bjorner, *Efficient E-matching for SMT solvers*, International Conference on Automated Deduction (CADE), 2007.

45. L. de Moura and N. Bjorner, *Model-based Theory Combination*, Workshop on Satisfiability Modulo Theories (SMT), 2007.

46. C. Barrett, L. de Moura and A. Stump, *Design and Results of the Second Satisfiability Modulo Theories Competition (SMT-COMP 2006)*, Journal of Formal Methods in System Design, 2007.

47. L. de Moura, B. Dutertre and N. Shankar, *A Tutorial on Satisfiability Modulo Theories*, Conference on Computer Aided Verification (CAV), 2007.

48. B. Dutertre and L. de Moura, *A Fast Linear-Arithmetic Solver for DPLL(T)* 18th International Conference on Computer Aided Verification (CAV'06).

49. C. Barrett, L. de Moura and A. Stump, *Design and Results of the 1st Satisfiability Modulo Theories Competition (SMT-COMP 2005)* Journal of Automated Reasoning (JAR), 2006.

50. C. Barrett, L. de Moura and A. Stump, *SMT-COMP: Satisfiability Modulo Theories Competition* 17th International Conference on Computer Aided Verification (CAV'05).

51. G. Hamon, L. de Moura and J. Rushby, *Generating Efficient Test Sets with a Model Checker*, The Second IEEE International Conference on Software Engineering and Formal Methods (SEFM'04).

52. L. de Moura, H. Rueß and N. Shankar, *Justifying Equality*, Second Workshop on Pragmatics of Decision Procedures in Automated Reasoning (PDPAR'04).

53. L. de Moura, S. Owre, H. Rueß, J. Rushby, N. Shankar, M. Sorea and A. Tiwari, *SAL 2*, 16th International Conference on Computer Aided Verification (CAV'04).

54. L. de Moura and H. Rueß, *An Experimental Evaluation of Ground Decision Procedures*, 16th International Conference on Computer Aided Verification (CAV'04).

55. L. de Moura, H. Rueß, N. Shankar and J. Rushby, *The ICS decision procedures for embedded deduction*, Second International Joint Conference on Automated Reasoning (IJCAR'04).

56. H. Rueß and L. de Moura, *From Simulation to Verification (and Back)* Proceedings of the 2003 Winter Simulation Conference.

57. L. de Moura, H. Rueß, J. Rushby and N. Shankar, *Embedded Deduction with ICS*, Presented at the third High Confidence Software and Systems Conference, 2003.

58. L. de Moura, H. Rueß and M. Sorea, *Bounded Model Checking and Induction: From Refutation to Verification*, 15th International Conference on Computer Aided Verification (CAV'03).

59. L. de Moura, H. Rueß and M. Sorea, *Lazy Theorem Proving for Bounded Model Checking over Infinite Domains*, International Conference on Automated Deduction (CADE'02).

60. L. de Moura, C.J. P. de Lucena and E.H. Haeusler, *Analysis of Parallel Programs*, Eletronic Notes in Theoretical Computer Science, 2002.

61. L. de Moura and H. Rueß, *Lemmas on Demand for Satisfiability Solvers*, Fifth International Symposium on the Theory and Applications of Satisfiability Testing (SAT), 2002.

62. L. de Moura, *Semantic-Directed Generation of Program Analysis and Verification Tools*, Second Prize in the ACM'2000 Student Research Contest, Austin, Texas, 2000.

63. L. de Moura, C. J. P. de Lucena and E. H. Hausler, *Analysis of Parallel Programs*, Brazilian Symposium of Programming Languages (SBLP), 2000.

64. L. de Moura, C. J. P. de Lucena and E. H. Hausler, *A Modular Implementation of Action Notation*, International Workshop on Action Semantics and Related Frameworks, 2000.

65. M. F. Fontoura, C. Braga, L. de Moura and C. J. P. de Lucena, *Using Domain Specific Languages to Instantiate Object-Oriented Frameworks*, IEE Proceedings - Software, 147(4), 2000.

66. M. F. Fontoura, L. de Moura, S. Crespo and C. J. P. de Lucena, *ALADIN: An Architecture for Learningware Application Design and Instantiation*, World Wide Web WWW Baltzer Science, Bussum, Holand, 2000.

67. I. D. Baxter, A. Yahin, S. Nedunuri, and L. de Moura, *Lowering Maintenance Costs by Code Clone Removal*, 12th International Software Quality Week, 1999.

68. L. de Moura, C. J. P. de Lucena and A. von Staa, *The Spider Environment*, Software Practice & Experience, 29(2), 99-124, 1999.

69. I. D. Baxter, A. Yahin, L. de Moura, M. Sant'Anna and L. Bier, *Clone Detection Using Abstract Syntax Trees*, Proc. of the International Conference on Software Maintenance'98, 1998, IEEE Press.

70. L. de Moura and C. J. P. de Lucena, *An Introduction To The Spider Visual Programming Environment*, Brazilian Symposium of Software Engineering (SBES), 1997.

71. H. Fuks and L. de Moura, *Supporting Team Collaboration*, SIGOIS Bulletin 16, New York, pp.64-68, 1995.

72. H. Fuks and L. de Moura, *A Document Based Approach for Cooperation*, Journal of the Brazilian Computer Society, V1, N1, pp 36-45, July 1994.

73. L. de Moura and R. R. dos Santos, *Critical Exponents for Site-Bond Correlated Percolation*, Phys. Review B 45, 1023, 1992.

Patents

- L. de Moura and N. Bjorner, *Matching based pattern inference for SMT solvers*, US Patent 9,489,221.
- L. de Moura and N. Bjorner, *Relevancy propagation for efficient theory combination*, US Patent 8,140,459.
- L. de Moura and N. Bjorner, *E-matching for SMT solvers*, US Patent 8,103,674.
- L. de Moura and N. Bjorner, *Model-based theory combination*, US Patent 7,925,476.
- J. Rushby, L. de Moura, G. Hamon, *Formal methods for test case generation*, US Patent 7,865,339.
- L. de Moura and H. Rueß, *Method for combining decision procedures with satisfiability solvers*, US Patent 7,653,520.

Professional Activities

- Member of the Program Committee of the International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2019.
- Member of the Program Committee of the 10th International Conference on Interactive Theorem Proving (ITP), 2019.
- Member of the Program Committee of the 25th International Conference on Types for Proofs and Programs (TYPES), 2018.

- Member of the Program Committee of the 9th International Joint Conference on Automated Reasoning (IJCAR), 2018.
- Member of the Program Committee of the 9th International Conference on Interactive Theorem Proving (ITP), 2018.
- Chair of 26th International Conference on Automated Deduction, 2017.
- Member of the Program Committee of the 24th International Conference on Types for Proofs and Programs (TYPES), 2017.
- Member of the Program Committee of the 26th International Conference on Automated Reasoning with Analytic Tableaux and Related Methods, 2017.
- Chair of the Calculemus track at Conference on Intelligent Mathematics, 2016.
- Member of the Program Committee of the International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2016.
- Member of the PhD Committee for Soonho Kong, Carnegie Mellon University, 2015.
- Member of the Program Committee of the NASA Formal Methods Symposium (NFM), 2015.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2015.
- Member of the Masters thesis committee for Robert Lewis, Carnegie Mellon University, 2014.
- Member of the Program Committee of the International Conference on Automated Deduction (CADE, 2014).
- Member of the Program Committee of the International Conference on Automated Deduction (CADE, 2013).
- Member of the Program Committee of the International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2013.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2013.
- Member of the PhD committee for Chantal Keller, École Polytechnique, 2013.
- Member of the Program Committee of the 5th NASA Formal Methods Symposium (NFM), 2013.

- Chair of the 16th Brazilian Symposium on Formal Methods (SBMF), 2013.
- Member of the PhD committee for Dejan Jovanović, New York University, 2012.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2012.
- Member of the Program Committee of the International Symposium on Formal Methods (FM), 2012.
- Member of the Program Committee of the International Conference on Verified Software: Theories, Tools, and Experiments (VSTTE), 2012
- Member of the Program Committee of the International Conference on Automated Deduction (CADE, 2011).
- Member of the Program Committee of the Workshop on Satisfiability Modulo Theories (SMT), 2011.
- Member of the PhD committee for Christoph Wintersteiger, ETH Zurich, Switzerland, 2011.
- Member of the Program Committee of the Symposium on Logic in Computer Science (LICS), 2011.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2011.
- Member of the Steering Committee of the Workshop on Satisfiability Modulo Theories (SMT), 2009-2011.
- Member of the PhD committee for Alberto Griggio, University of Trento, Italy, 2010.
- Member of the Program Committee of the International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS), 2010.
- Member of the PhD committee for Yeting Ge, New York University, 2009.
- Member of the Program Committee of the International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2009.
- Member of the Program Committee of the Workshop on Satisfiability Modulo Theories (SMT), 2009.
- Member of the Program Committee of the Workshop on Automated Formal Methods (AFM), 2009.
- Member of the Program Committee of the Workshop on Automated Formal Methods (AFM), 2008.

- Member of the Program Committee of the International Conference on Frontiers of Combining Systems (FroCoS), 2008.
- Chair of the Workshop on Satisfiability Modulo Theories (SMT), 2008.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2008.
- Member of the Program Committee of the Workshop on Bit-Precise Reasoning (BPR), 2008.
- Member of the Program Committee of the Workshop on Automated Formal Methods (AFM), 2007.
- Member of the Program Committee of the Workshop on Satisfiability Modulo Theories (SMT), 2007.
- Member of the Program Committee of the International Conference on Satisfiability (SAT), 2007.
- Organizer of the 2nd Satisfiability Modulo Theories Competition (SMT-COMP), 2006.
- Member of the Program Committee of the International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2006
- Member of the Program Committee of Pragmatics of Decision Procedures in Automated Reasoning (PDPAR), 2006.
- Tutorial Chair of the International Conference on Formal Methods in Computer-Aided Design (FMCAD), 2006.
- Organizer of the 1st Satisfiability Modulo Theories Competition (SMT-COMP), 2005.

Teaching

- Winter 2016, Course on "Dependent Type Theory", RIO 2016 Summer School, 2016.
- Sprint 2015, Lecture on "Higher-order unification" in the interactive theorem proving course at CMU (Jeremy Avigad and Ed Clarke's course).
- Summer 2014, Lectures on "Nonlinear arithmetic", SAT/SMT Summer School, Vienna, Austria.
- Summer 2013, Lectures on "Decision Methods for Arithmetic", Third Summer School on Formal Techniques, Menlo Park.
- Spring 2013, Course on "Tools and Algorithms in Real Algebraic Geometry", Universita Degli Studi di Milano, Italy, March.

- Summer 2012, Lectures on "Quantifiers in Satisfiability Modulo Theories", SAT/SMT Summer School, Trento, Italy.
- Summer 2012, Lectures on "Satisfiability Modulo Theories", Second Summer School on Formal Techniques, Menlo Park.
- Summer 2011, Lectures on "Satisfiability Modulo Theories", First Summer School on Formal Techniques, Menlo Park.
- Spring 2010, Course on "Satisfiability Modulo Theories (SMT): Ideas & Applications", Universita Degli Studi di Milano, Italy, March.
- Autumn 2009, Lectures on "Designing and Implementing Satisfiability Modulo Theory Solvers", Summer School organized by Max Planck Institut and INRIA, Nancy.
- Summer 2008, Lectures on "SMT Solvers: Theory and Implementation", Summer School on Logic and Theorem Proving in Programming Languages, Oregon.
- Spring 2007, Lecture on "SMT solvers" at CMU (Ed Clarke's course).
- Summer 2004, Lecture in the Stanford/SRI Summer School on Combination of Decision Procedures.
- Fall 2003, Little Engines of Proof (CS359), Stanford.

References

Dr. Thomas Ball
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