Anders Franzén

Education

2010 **PhD**, *University of Trento*, Trento, Italy.
Thesis title: "Efficient Solving of the Satisfiability Modulo Bit-Vectors Problem and Some Extensions to SMT"

2004 **MSc**, *Chalmers University of Technology*, Gothenburg, Sweden.
Thesis title: "Combining SAT Solving with Integer Programming for Inductive Verification of Lustre Programs"

Experience

2012– **Sr. Staff R&D Engineer**, *Jasper Design Automation*, Gothenburg, Sweden.
Working on model checking engines for formal verification of hardware designs

2010–2012 **R&D SW Engineer**, *Jasper Design Automation*, Gothenburg, Sweden.
Working on model checking engines for formal verification of hardware designs

2008–2008 **Intern**, *Intel Corp.*, Haifa, Israel.
Integration of MathSAT into the MicroFormal tool chain, used for microcode verification. Successfully applied to the verification of a next-generation microarchitecture

2005–2005 **Developer**, *University of Trento*, Trento, Italy.
Developer on the MathSAT team. MathSAT is a state-of-the-art SMT solver

2004–2004 **Teacher**, *Chalmers Lindholmen*, Gothenburg, Sweden.
Taught Concurrent Programming, Teaching assistant/guest lecturer in other courses

2000–2003 **Developer**, *Safelogic AB*, Gothenburg, Sweden.
Working on Safelogic Verifier, a tool for formal verification of VHDL-based hardware designs. Project leader for the next version of Safelogic Verifier

1998–2004 **Teacher**, *Chalmers Lindholmen*, Gothenburg, Sweden.
Assistant on several courses in programming, real-time systems, microcomputer systems, operating systems, and others. Developed and taught the course Concurrent Programming for four years

1998–2005 **Consultant**, Gothenburg, Sweden.
Focused on software development and teaching, with assignments for among others AstraZeneca R&D Mölndal working on software for gene expression analysis, SAS programming

+46 (0)722 140103 • anders@residual.se • www.residual.se

Sample Software

MathSAT State-of-the-art Satisfiability Modulo Theories solver. Most notable contributions: support for the theory of fixed width bit-vectors, which led MathSAT to win the QF_BV category in SMT-COMP 2009, and integration into MicroFormal, a tool chain used at Intel Corp. for microcode verification, outperforming the previously used solver. The 2009 competition version ran *hors concours* in SMT-COMP 2010, where it still clearly outperformed competing solvers in the QF_BV category.

`http://mathsat4.disi.unitn.it`

PB/CT Solver for the Pseudo-Boolean Optimization problem. PB/CT is based on the OpenSMT SMT solver extended with the theory of costs, a theory which permits reasoning with pseudo-boolean functions without modifications to the basic DPLL(T) architecture of the SMT solver. The solver participated in the 2010 Pseudo Boolean Competition.

`http://www.residual.se/pbct`

mcsti Model Checker based on k-induction, using lazy instantiation of the unique path restriction and automatic invariant discovery. The system participated in the 2010 Hardware Model Checking Competition.

`http://www.residual.se/mcsti`

Awards

Best Paper Applying SMT to Symbolic Execution of Microcode, FMCAD 2010

Publications

Marco Bozzano, Roberto Bruttomesso, Alessandro Cimatti, Anders Franzén, Ziyad Hanna, Zurab Khasidashvili, Amit Palti, and Roberto Sebastiani. Encoding RTL Constructs for MathSAT: a Preliminary Report. In *Electr. Notes Theor. Comput. Sci.*, volume 144, pages 3–14, 2006.

Roberto Bruttomesso, Alessandro Cimatti, Anders Franzén, Alberto Griggio, Ziyad Hanna, Alexander Nadel, Amit Palti, and Roberto Sebastiani. A Lazy and Layered SMT($\mathcal{BV}$) Solver for Hard Industrial Verification Problems. In *CAV'07*, volume 4590 of *Lecture Notes in Computer Science*, pages 547–560. Springer, 2007.

Roberto Bruttomesso, Alessandro Cimatti, Anders Franzén, Alberto Griggio, Alessandro Santuari, and Roberto Sebastiani. To Ackermann-ize or Not to Ackermann-ize? On Efficiently Handling Uninterpreted Function Symbols in SMT(UF $\cup$ T). In *LPAR 2006*, volume 4246 of *Lecture Notes in Computer Science*, pages 557–571. Springer, 2006.

Roberto Bruttomesso, Alessandro Cimatti, Anders Franzén, Alberto Griggio, and Roberto Sebastiani. Delayed Theory Combination vs. Nelson-Oppen for Satisfiability Modulo Theories: A Comparative Analysis. In *LPAR 2006*, volume 4246 of *Lecture Notes in Computer Science*, pages 527–541. Springer, 2006.

Roberto Bruttomesso, Alessandro Cimatti, Anders Franzén, Alberto Griggio, and Roberto Sebastiani. The MathSAT 4 SMT Solver. In *CAV'08*, volume 5123 of *Lecture Notes in Computer Science*, pages 299–303. Springer, 2008.

Roberto Cavada, Alessandro Cimatti, Anders Franzén, Krishnamani Kalyanasundaram, Marco Roveri, and R. K. Shyamasundar. Computing Predicate Abstractions by Integrating BDDs and

SMT Solvers. In *Formal Methods in Computer-Aided Design*, pages 69–76. IEEE Computer Society, 2007.

Alessandro Cimatti, Anders Franzén, Alberto Griggio, Roberto Sebastiani, and Cristian Stenico. Satisfiability Modulo the Theory of Costs: Foundations and Applications. In *TACAS'10*, volume 6015 of *Lecture Notes in Computer Science*, pages 99–113. Springer, 2010.

Anders Franzén. Combining SAT Solving with Integer Programming for Inductive Verification of Lustre. Master's thesis, Chalmers University of Technology, 2004.

Anders Franzén. Using Satisfiability Modulo Theories for Inductive Verification of Lustre Programs. *Electr. Notes Theor. Comput. Sci.*, 144(1):19–33, 2006.

Anders Franzén. *Efficient Solving of the Satisfiability Modulo Bit-Vectors Problem and Some Extensions to SMT*. PhD thesis, Università degli Studi di Trento, March 2010.

Anders Franzén, Alessandro Cimatti, Alexander Nadel, Roberto Sebastiani, and Jonathan Shalev. Applying SMT in Symbolic Execution of Microcode. In *FMCAD 2010*, to appear.