Alexandre Maréchal

Education

2014-2017 **Ph.D**, *Verimag - Université Grenoble Alpes*, Grenoble.

2014 **Magistère d'Informatique**, *Université Joseph Fourier*, Grenoble, *with high honours*.

2014 **Master Research Mathématiques Informatique, specialty Informatique, option Recherche Opérationnelle, Combinatoire et Optimisation**, *Université Joseph Fourier*, Grenoble, *with high honours*.

2012 **Bachelor Informatique et Mathématiques Appliquées**, *Université Joseph Fourier*, Grenoble, *with high honours*.

2008 **Bac S Science de l'Ingénieur, specialty Mathématiques**, *Lycée Anna de Noailles*, Evian-les-bains, *with highest honours*.

Ph.D Thesis

Title *New Algorithmics for Polyhedral Calculus via Parametric Linear Programming*

Advisors Michaël Périn, David Monniaux

Abstract This thesis presents the design and implementation of the Verified Polyhedra Library (VPL), a scalable library for polyhedral calculus. It provides Coq-certified polyhedral operators that work on constraints-only representation. The previous version was inefficient on crucial operations, namely variable elimination and convex hull. In this work, I present major improvements that have been made in scalability, modularity and simplicity: The certification process is generalized and simplified; polynomial guards can now be handled; computations that do not involve certification may use floating-point numbers; new algorithms are presented for minimization and detection of implicit equalities.
On the one hand, the implementation of a solver for Parametric Linear Programming (PLP) problems led to improved scalability both in the dimension and in the number of constraints. Variable elimination and convex hull are now encoded as PLP. PLP is a generic tool that has many applications, and that avoids generating redundancies thanks to a normalization constraint. Additionally, we provide new operators for handling multivariate polynomials, one of which also encoded as a PLP problem.
On the other hand, the certification part of the library has been greatly optimized and simplified. The VPL follows a result-verification paradigm, where complex computations are performed by untrusted oracles that generate witnesses of correctness, themselves validated by a certified Coq checker. Thanks to an innovative and powerful certification framework known as Polymorphic Factory Style (PFS), most cumbersome parts of the witness generation are now avoided. The flexibility of PFS is attested by the creation of a Coq tactic for learning equalities in linear arithmetic.

6 allée de Combeloup – 38610 Gières – France
06 75 94 68 98 • *marechalalex@gmail.com*

Jury
- Pr. Sylvain CONCHON, Université Paris-Sud, president
- Pr. Antoine MINÉ, Université Pierre et Marie Curie - Paris 6, reviewer
- Pr. Sriram SANKARANARAYANAN, University of Colorado Boulder
- Pr. Philippe CLAUSS, Université de Strasbourg, examiner
- Dr. Charlotte TRUCHET, Université de Nantes, examiner

Master Thesis

Title *Three linearization techniques for multivariate polynomials in static analysis using convex polyhedra*

Advisors Michaël Périn, David Monniaux

Abstract This document presents three linearization approaches that over-approximate polynomial constraints with convex polyhedra. The first approach is based on the substitution of some variables of nonlinear products by intervals. The second one consists in expressing polynomials in the Bernstein basis to deduce a polyhedron from the Bernstein coefficients. The last one uses Handelman's theorem to approximate polynomials by products of constraints of an input polyhedron.
Available as a technical report at `http://www-verimag.imag.fr/TR/TR-2014-7.pdf`

Work Experience

2014-2018 **Ph.D Thesis**, Verimag, Grenoble.
Duration: 3 years, 5 months

2014 **Magistère's traineeship**, Verimag, Grenoble.
Duration: 8 months
- Coq proof of a linearization algorithm by intervalization
- New linearization approach based on Handelman's theorem

2013 **Magistère's traineeship**, Verimag, Grenoble.
Duration: 4 months
Coq design of a linearization algorithm

2012 **Bachelor Traineeship**, Verimag, Grenoble.
Duration: 2 months
Loop acceleration and Craig interpolation for the verification of numerical programs

Skills

Languages

French **native**

English **level C1**

Computer Science

Languages OCaml, Java, Python, Coq, C

Scientific calculus Sage, Matlab, Maple

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Publications

Alexandre Maréchal and Michaël Périn. A Linearization Technique for Multivariate Polynomials Using Convex Polyhedra Based on Handelman-Krivine's Theorem. In *Journées Francophones des Langages Applicatifs (JFLA)*, January 2015.

Sylvain Boulmé and Alexandre Maréchal. Refinement to certify abstract interpretations, illustrated on linearization for polyhedra. In *Interactive Theorem Proving (ITP)*, volume 9236 of *LNCS*, pages 100–116. Springer, 2015.

Alexandre Maréchal, Alexis Fouilhé, Tim King, David Monniaux, and Michaël Périn. Polyhedral approximation of multivariate polynomials using Handelman's theorem. In *Verification, Model Checking, and Abstract Interpretation (VMCAI)*, LNCS, pages 166–184. Springer, 2016.

Alexandre Maréchal and Michaël Périn. Efficient elimination of redundancies in polyhedra by raytracing. In *Verification, Model Checking, and Abstract Interpretation (VMCAI)*, volume 10145 of *LNCS*, pages 367–385. Springer, 2017.

Alexandre Maréchal, David Monniaux, and Michaël Périn. Scalable minimizing-operators on polyhedra via parametric linear programming. In *Static Analysis Symposium (SAS)*, volume 10422 of *LNCS*. Springer, 2017.

Teaching

2016-2017

L2 Introduction à la logique (36h TD)

M1 Langages et Traducteurs (17h TD)

2015-2016

L2 Bases du développement logiciel (15h CM/TD - 15h TP)

L1 Algorithmique et Programmation Fonctionnelle (18h TD - 21h TP)

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