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Personal Details:

Born August 1984; Romanian nationality.

Work:

- Jan 2013 - CNRS Researcher (CRCN, Section 06) in MAC Team, LAAS-CNRS, Toulouse, France.
2011 - 2013 Postdoctorant, Computer-aided proofs in analysis (CAPA) Team, Mathematics Department, Uppsala Univ., Sweden.

Education

- 2008 -2011 **PhD in Computer Science** at École Normale Supérieure de Lyon.
Mention: Très Honorable. Thesis subject: *Rigorous polynomial approximations and applications*.
Phd advisors: Nicolas Brisebarre and Jean-Michel Muller.
- 2007 - 2008 **Master Diploma in Computer Science** at École Normale Supérieure de Lyon.
Mention: Good. Master report subject: *Computation of various infinite norms, in one or several variables, for the development of mathematical libraries*. Supervisors: Nicolas Brisebarre and Jean-Michel Muller.
- 2003 - 2008 **Engineer Diploma** obtained in June 2008 from Technical University of Cluj-Napoca, Computer Science Department, English Section, grade 10/10.

Research statement

Rigorous computing (validated computing): use numerical computations, but provide mathematical statements about the obtained result, such as sure, yet reasonably tight, error bounds. Build efficient symbolic-numeric objects, algorithms and software tools with direct applications in control of dynamical systems and in particular in the aerospace domain. Use and develop expertise and ideas from *Computer Arithmetic*, *Computer Algebra*, *Dynamical Systems*.

Research Projects

ANR FASTRELAX: *Fast and Reliable Approximation*, 60 months, 600kEuros, 2014-2019. I am the scientific responsible of the LAAS-CNRS research partner, with a participation ratio of 28.6 person.month. Other partners: INRIA Centre Grenoble Rhône-Alpes, INRIA Saclay-Idf, INRIA - Centre Sophia Antipolis - Méditerranée, Université Pierre et Marie Curie (UPMC) - Paris 6. Head of the project: Bruno Salvy (Inria, AriC, Lip).

Research collaboration contract (2014-2015) with Airbus Defence and Space (formerly known as Astrium): *Méthodes d'optimisation probabiliste pour l'évitement de collision spatiale*, head of project: Denis Arzelier (LAAS);.

Research collaboration contract (2016-2018) with CNES: project leader of *R&T CNES Global Collision Probability and Satellites Station Keeping*.

Collaboration with Academic Partners

CAPA Team, Uppsala, Sweden Since 2011 I collaborate with Computer Aided Proofs in Analysis (CAPA) team, Mathematics Department, Uppsala, Sweden. I work with Prof. Warwick Tucker for solving problems in Discrete Dynamical Systems in with the help of high performance computing. For that, we do mutual visits and research seminars.

AriC Team, LIP, Lyon I tightly collaborate with AriC Team in various projects (thesis of V. Popescu, ANR FastRelax and thesis of F. Bréhard) related to Computer Arithmetic and Computer Algebra (N. Brisebarre, J.-M. Muller, V. Popescu, B. Salvy). We hope that this collaboration will result in a broader visibility, understanding and application of arithmetic and computer algebra techniques for the automatic control community.

Pequan Team, LIP6, Paris I collaborated with my co-authors M. Mezzarobba and Ch. Lauter in the field of validated methods using truncated power or Chebyshev series.

Invited stays and talks

- **January and June 2018:** Invited course and talk at Winter Workshop on Dynamics, Topology and Computations, and DyToComp in Bedlewo, Poland.
- **October 2017:** Plenary talk at RAIM 2017: Rencontres Arithmetique de l'Informatique Mathématique, Lyon, France.
- **July 2017:** Semi-Plenary talk at Foundations of Computational Mathematics, FOCM2017, Barcelona, Spain.
- **May 2017:** Invited visit and talk at the Department of Mechanical & Aerospace Engineering at the University of Strathclyde, Glasgow, UK
- **September 2016:** Invited plenary talk at 17th International Symposium on Scientific Computing, Computer Arithmetics and Verified Numerics, Uppsala, Sweden
- **2016:** Invited seminars at DALI team, Perpignan France; SpecFun team Inria Saclay, France
- **2015:** Invited talks at CMS Summer Meeting in Charlottetown, University of Prince Edward Island, Canada and 13th International Symposium on Orthogonal Polynomials, Special Functions and Applications (OPSFA-13), SIAM, National Institute of Standards and Technology (NIST), MD, USA.
- **March 2011 and December 2014:** CAPA Group, Uppsala University, Sweden.
- **October 2014 and May 2013:** AriC Team, LIP, Lyon, France.
- **April 2012:** one week at National Institute of Aerospace, Hampton, Virginia, USA.

Supervision

PhD students:

2016– Co-Supervision of F. Bréhard, with N. Brisebarre and D. Pous (LIP, ENS Lyon), *Certified tools for numerical analysis*.

2015– 2018 Co-Supervision of P.R. Arantes Gilz, with C. Louembet (MAC, LAAS), *Embedded and validated control algorithms for the spacecraft rendezvous*. Defended October 2018.

2014–2017 Co-Supervisor of V. Popescu, with Jean-Michel Muller, AriC, Lyon. Title: *Towards Fast and Certified Multiple Precision Arithmetic Libraries*. Defended July 2017.

Licence and Master students:

2018: Marco Felice Montaruli, M2, joint supervision with Sophie Laurens (CNES) and Denis Arzelier; Damien Guého, M1, joint supervision with Sophie Laurens (CNES), Denis Arzelier and Aude Rondepierre (ROC, LAAS).

2017: Léo Martire: M2, joint supervision with Denis Arzelier and Aude Rondepierre;

2015-2016 Florent Bréhard: M2 intenship, joint supervision with N. Brisebarre and D. Pous (LIP, ENS Lyon);

2014 Valentina Popescu, Master 2 Internship, July 2014;

2018 Ana-Maria Nanes, L3, joint supervision with Jean-Michel Muller, Error analysis of fast multiplication algorithms.

2015 Co-Supervisor N. Deak, (Licence 3, now Master Student ant ENS Lyon), with C. Louembet and D. Arzelier, MAC, LAAS-CNRS; B. Fulop, (Licence 3, now Master Student ant ENS Lyon), with N. Brisebarre, AriC, LIP, ENS Lyon.

2014 Co-Supervisor of O. Marty, (Licence 3, now PhD Student at ENS Cachan)

Program Committee, Reviewing

I am/was member of the program committee of the following international conferences: SYNASC2016, ISSAC2017, ARITH2019. I am reviewer for international journals: Numerical Algorithms, Mathematics in Computer Science, IEEE Transactions in Computers, VLSI Journal; ACM Transactions on Mathematical Software, Communications in Nonlinear Science and Numerical Simulation, Nonlinear Dynamics, Automatica, and international conferences ASAP(2013–2016), Arith(2012-2018), CIFA(2012), ISAAC(2012–2018), SYNASC(2016).

(I.e., approximately 100 reviews).

Research Themes, Results and Objectives

A. Computer Arithmetic

We developed algorithms for fast and certified multiple precision arithmetic operations (also tuned for Graphics Processing Units). We targeted high-performance computing problems which require multiple precision e.g., the study of strange attractors such as the Hénon attractor [7]. Use *floating-point expansions* that is, extended precision is represented as the unevaluated sum of standard machine floating-point numbers.

Recent results: efficient and accurate (with proven error bounds) algorithms for normalization, division and sqrt [6], [3], [20], [12], [17]. Part of this research was published in the book [1].

Objectives: formally proven algorithms, elementary functions implementation.

B. Rigorous Polynomial Approximation (RPA)

A polynomial approximation together with rigorous error bounds. Use *Taylor Models* [8, 26, 27, 21] and *Chebyshev polynomial interpolation/series Models* [23], [31, Chap. 4]. Adapt to rigorous computations many numerical algorithms based on Chebyshev / Taylor Series for solving ordinary differential equations, quadrature, etc.

Recent results: compute rigorous uniform approximations based on Chebyshev Series for *D-finite functions*, i.e. solutions of ordinary differential equations with polynomial coefficients [4] e.g., erf, exp, sin, Bessel, Airy functions; efficient computations of supremum norms of approximation errors [8]; formally proven Taylor Models [21]. With F. Bréhard and N. Brisebarre, we developed a validated numerics method for the solution of linear ordinary differential equations (LODEs). A theoretical and practical complexity analysis of a so-called a posteriori quasi-Newton validation method is given in [2].

Objectives: efficient implementation of operations with Chebyshev Models, extensions to multivariate functions; efficient finite precision evaluation of power series.

C. Applications to Optimal Control and Aerospace

We proposed a new accurate, reliable and efficient method to compute a *certified orbital collision probability* between two spherical space objects involved in a short-term encounter under Gaussian-distributed uncertainty. In this model of conjunction, the probability of collision is reduced to the integral of a 2D Gaussian probability density function over a disk. Our computational method is based on an analytic expression for the integral, derived by use of *Laplace transform* and *D-finite functions* [18, 19, 5]. This work is to be extended to long term or multiple encounters during the R&T CNES project Global Collision Probability and Satellites Station Keeping (started 09/16)

With P. Arantes Gilz, C. Louembet et F. Camps, we proposed a model predictive control strategy for the hovering phases of the impulsive spacecraft rendezvous. The path constraints (box-type and periodicity) are satisfied continuously in time, based on a particular parametrization of the linearized relative spacecraft trajectories. Hardware-in-the-loop simulations, using a synthesized LEON3 microprocessor which is compatible with space devices, are performed to assess the efficiency and robustness of the proposed approach [10], [13].

Publications

Book

- [1] Jean-Michel Muller, Nicolas Brunie, Florent de Dinechin, Claude-Pierre Jeannerod, Mioara Joldes, Vincent Lefèvre, Guillaume Melquiond, Nathalie Revol, and Serge Torres. *Handbook of Floating-Point Arithmetic*. Birkhäuser, 2018.

International peer-reviewed journals

- [2] Florent Bréhard, Nicolas Brisebarre, and Mioara Joldeş. Validated and numerically efficient chebyshev spectral methods for linear ordinary differential equations. *ACM Transactions on Mathematical Software (TOMS)*, 44(4):44, 2018.
- [3] Mioara Joldes, Jean-Michel Muller, and Valentina Popescu. Tight and rigorous error bounds for basic building blocks of double-word arithmetic. *ACM Transactions on Mathematical Software (TOMS)*, 44(2):15res, 2017.
- [4] Alexandre Benoit, Mioara Joldes, and Marc Mezzarobba. Rigorous uniform approximation of D-finite functions using Chebyshev expansions. *Mathematics of Computation*, 2015. Accepted for publication.
- [5] Romain Serra, Denis Arzelier, Mioara Joldes, Jean-Bernard Lasserre, Aude Rondepierre, and Bruno Salvy. Fast and accurate computation of orbital collision probability for short-term encounters. *Journal of Guidance, Control, and Dynamics*, 39(5):1009–1021, 2016.
- [6] Mioara Joldes, Olivier Marty, Jean-Michel Muller, and Valentina Popescu. Arithmetic algorithms for extended precision using floating-point expansions. *IEEE Transactions on Computers*, 65(4):1197–1210, April 2016.
- [7] Mioara Joldes, Valentina Popescu, and Warwick Tucker. Searching for sinks for the Hénon map using a multipleprecision GPU arithmetic library. *SIGARCH Comput. Archit. News*, 42(4):63–68, December 2014.
- [8] Sylvain Chevillard, John Harrison, Mioara Joldes, and Christoph Lauter. Efficient and accurate computation of upper bounds of approximation errors. *Theoretical Computer Science*, 16(412):1523–1543, 2011.

Publications in the peer-reviewed proceedings of international conferences

- [9] Romain Serra, Denis Arzelier, Florent Bréhard, and Mioara Joldes. Fuel-optimal impulsive fixed-time trajectories in the linearized circular restricted 3-body-problem. In *IAF Astrodynamics Symposium in 69TH international astronomical congress*, 2018.
- [10] Frédéric Camps, Paulo Ricardo Arantes Gilz, Mioara Joldes, and Christophe Louembet. Embedding a sdp-based control algorithm for the orbital rendezvous hovering phases. In *Proceedings of the IEEE International Conference on Integrated Navigation Systems, Jun 2018, Saint Petersburg, Russia*. 10.23919/ICINS.2018.8405931. IEEE, 2018.
- [11] Mioara Joldes, Jean-Michel Muller, and Valentina Popescu. Implementation and performance evaluation of an extended precision floating-point arithmetic library for high-accuracy semidefinite programming. In *Computer Arithmetic (ARITH), 2017 IEEE 24th Symposium on*, pages 27–34. IEEE, 2017.
- [12] Sylvie Boldo, Mioara Joldes, Jean-Michel Muller, and Valentina Popescu. Formal verification of a floating-point expansion renormalization algorithm. In *International Conference on Interactive Theorem Proving*, pages 98–113. Springer, 2017.
- [13] Paulo Ricardo Arantes Gilz, Mioara Joldes, Christophe Louembet, and Frédéric Camps. Model predictive control for rendezvous hovering phases based on a novel description of constrained trajectories. volume 50, pages 7229–7234. Elsevier, 2017.
- [14] Denis Arzelier, Florent Bréhard, Norbert Deak, Mioara Joldes, Christophe Louembet, Aude Rondepierre, and Romain Serra. Linearized impulsive fixed-time fuel-optimal space rendezvous: A new numerical approach. In *Proceedings of the 20th IFAC Symposium on Automatic Control in Aerospace, 21-25 August, 2016, Sherbrooke, Quebec, Canada*, 2016.
- [15] Sylvain Collange, Mioara Joldes, Jean-Michel Muller, and Valentina Popescu. Parallel floating-point expansions for extended-precision gpu computations. In *Proceedings of ASAP 2016: The 27th Annual IEEE International Conference on Application-specific Systems, Architectures and Processors, 6-8 July 2016, London, England*. IEEE, 2016.
- [16] Florent Bréhard, Nicolas Brisebarre, and Mioara Joldes. A new efficient algorithm for computing validated chebyshev approximations solutions of linear differential equations. In *SCAN 2016: 17th International Symposium on Scientific Computing, Computer Arithmetic and Verified Numerics, Uppsala, Sweden, Sept. 2016*, pages 41–43, 2016.

- [17] Mioara Joldes, Jean-Michel Muller, Valentina Popescu, and Warwick Tucker. Campary: Cuda multiple precision arithmetic library and applications. In Gert-Martin Greuel, Thorsten Koch, Peter Paule, and Andrew Sommese, editors, *Mathematical Software – ICMS 2016: 5th International Conference, Berlin, Germany, July 11-14, 2016, Proceedings*, pages 232–240, Cham, 2016. Springer International Publishing.
- [18] Romain Serra, Denis Arzelier, Mioara Joldes, Jean-Bernard Lasserre, Aude Rondepierre, and Bruno Salvy. A new method to compute the probability of collision for short-term space encounters. In *Astrodynamics Specialist Conference*, pages 1–7, Aug 2014.
- [19] Romain Serra, Denis Arzelier, Mioara Joldes, and Aude Rondepierre. Probabilistic collision avoidance for long-term space encounters via risk selection. In *3rd CEAS European Aerospace Guidance, Navigation and Control (EuroGNC) Conference*, pages –21, Dec 2014.
- [20] Mioara Joldes, Jean-Michel Muller, and Valentina Popescu. On the computation of the reciprocal of floating point expansions using an adapted Newton-Raphson iteration. In *IEEE 25th International Conference on Application-Specific Systems, Architectures and Processors, ASAP 2014, Zurich, Switzerland, June 18-20, 2014*, pages 63–67. IEEE, 2014.
- [21] Nicolas Brisebarre, Mioara Joldes, Érik Martin-Dorel, Micaela Mayero, Jean-Michel Muller, Ioana Pasca, Laurence Rideau, and Laurent Théry. Rigorous polynomial approximation using Taylor Models in Coq. In Alwyn Goodloe and Suzette Person, editors, *NASA Formal Methods - 4th International Symposium, NFM 2012, Norfolk, VA, USA, April 3-5, 2012. Proceedings*, volume 7226 of *Lecture Notes in Computer Science*, pages 85–99. Springer, 2012.
- [22] Nicolas Brisebarre, Mioara Joldes, Peter Kornerup, Érik Martin-Dorel, and Jean-Michel Muller. Augmented precision square roots and 2-d norms, and discussion on correctly rounding $\sqrt{x^2+y^2}$. In Elisardo Antelo, David Hough, and Paolo Jenne, editors, *20th IEEE Symposium on Computer Arithmetic, ARITH 2011, Tübingen, Germany, 25-27 July 2011*, pages 23–30. IEEE Computer Society, 2011.
- [23] Nicolas Brisebarre and Mioara Joldes. Chebyshev interpolation polynomial-based tools for rigorous computing. In Wolfram Koepf, editor, *Symbolic and Algebraic Computation, International Symposium, ISSAC 2010, Munich, Germany, July 25-28, 2010, Proceedings*, pages 147–154. ACM, 2010.
- [24] Florent de Dinechin, Mioara Joldes, and Bogdan Pasca. Automatic generation of polynomial-based hardware architectures for function evaluation. In François Charot, Frank Hannig, Jürgen Teich, and Christophe Wolinski, editors, *21st IEEE International Conference on Application-specific Systems Architectures and Processors, ASAP 2010, Rennes, France, 7-9 July 2010*, pages 216–222. IEEE, 2010.
- [25] Florent de Dinechin, Mioara Joldes, Bogdan Pasca, and Guillaume Revy. Multiplicative square root algorithms for FPGAs. In *International Conference on Field Programmable Logic and Applications, FPL 2010, August 31 2010 - September 2, 2010, Milano, Italy*, pages 574–577. IEEE, 2010.
- [26] Sylvain Chevillard, Mioara Joldes, and Christoph Quirin Lauter. Sollya: An environment for the development of numerical codes. In Komei Fukuda, Joris van der Hoeven, Michael Joswig, and Nobuki Takayama, editors, *Mathematical Software - ICMS 2010, Third International Congress on Mathematical Software, Kobe, Japan, September 13-17, 2010. Proceedings*, volume 6327 of *Lecture Notes in Computer Science*, pages 28–31. Springer, 2010.
- [27] Sylvain Chevillard, Mioara Joldes, and Christoph Quirin Lauter. Certified and fast computation of supremum norms of approximation errors. In Javier D. Bruguera, Marius Cornea, Debjit Das Sarma, and John Harrison, editors, *19th IEEE Symposium on Computer Arithmetic, ARITH 2009, Portland, Oregon, USA, 9-10 June 2009*, pages 169–176. IEEE Computer Society, 2009.

Publications in the peer-reviewed proceedings of national conferences

- [28] Mioara Joldes, Valentina Popescu, and Warwick Tucker. Searching for sinks of Hénon map using a multiple-precision GPU arithmetic library. In *Forum des Jeunes Mathématicien-ne-s*, pages –6, Nov 2013.
- [29] Mioara Joldes. When a logarithm is a misspelled algorithm. In *Proceedings of the Association Femmes et mathématiques*, September 2010.
- [30] Florent de Dinechin, Mioara Joldes, Bogdan Pasca, and Guillaume Revy. Racines carrées multiplicatives sur FPGA. In *SYMPosium en Architectures nouvelles de machines (SYMPA)*, Toulouse, September 2009.

Articles under submission, research reports

- [31] Mioara Joldes. *Rigorous Polynomial Approximations and Applications*. Theses, École Normale Supérieure de Lyon - ENS LYON, September 2011. <https://tel.archives-ouvertes.fr/tel-00657843>.
- [32] Romain Serra, Denis Arzelier, Mioara Joldes, and Aude Rondepierre. Probability of collision between spherical space objects for short-term space encounters. Technical report, LAAS-CNRS No. 14154, Mars 2014. Astrium Funding for PhD.

Software

- **CAMPARY** –Cuda Multiple Precision ARithmetic librarY–. Multiple precision arithmetic routines based on Floating-Point Expansions for CPUs/GPUs, written in CUDA C. See <http://homepages.laas.fr/mmjoldes/campary/>. Developed with O. Marty, J.-M. Muller, V. Popescu and W. Tucker. Related articles: [7, 20, 17].
- **Unifapprox** Experimental Maple code for Rigorous Uniform Approximation of D-Finite Functions using Chebyshev Expansions. See <http://homepages.laas.fr/mmjoldes/Unifapprox/>. Developed with A. Benoit and M. Mezzarobba. Related articles: [4].
- **ChebModels**, developed with N. Brisebarre. Collects Maple packages developed for rigorous polynomial approximations to univariate functions. See <http://www.ens-lyon.fr/LIP/Arenaire/Ware/ChebModels/>. Related articles: [23].
- **FloPoCo**. FloPoCo is a generator of arithmetic cores (Floating-Point Cores, but not only) for FPGAs. See <http://www.ens-lyon.fr/LIP/Arenaire/Ware/FloPoCo/>. I developed a small specific part related to computing piecewise polynomial approximations for function evaluation specifically targeted for FPGAs. Related articles: [24, 25].
- **Sollya**. Sollya is a tool environment for safe floating-point code development. It is particularly targeted to the automatized implementation of mathematical floating-point libraries (libm). See <http://sollya.gforge.inria.fr/>. Since 2008 I joined S. Chevillard and Ch. Lauter for developing Sollya's functionalities mainly related to Taylor models and certified computation of supremum norms of approximation errors. Related articles: [8, 21, 26, 27].

PhD Defense Juries

Member of Jury of Guillaume Rance thesis, *Commande H-infinie paramétrique et application aux viseurs gyrostabilisés*, Centrale Supélec, July 2018.

Reviewer (Principal Opponent) of Ferenc M. Bartha thesis, entitled *Computer-aided proofs and algorithms in analysis*, for the PhD-degree of the University of Bergen, Mathematics Department, Norway, June 14, 2013.

Member of Jury for Romain Serra thesis, entitled *Opérations de proximité en orbite : évaluation du risque de collision et calcul de manœuvres optimales pour l'évitement et le rendez-vous (In-orbit Servicing: Collision Risk Assessment and Optimal Maneuvers for Collision Avoidance and Rendezvous)*, December 12, 2015, Toulouse, INSA, LAAS-CNRS.

Teaching

2012 *Qualification "Maître de conférences"*, Section CNU 26 (Applied Mathematics); 27 (Informatics).

2014–2015 Plenary lectures in the Automatic Control Course of Denis Arzelier at ENSICA, Toulouse: *Automatique des systèmes linéaires (L2 level)*, 5h.

2014–2015 *Travaux Pratiques*, M1 level, Université Toulouse 3, Paul Sabatier: *Méthodes et outils de Conception Assisté par Ordinateur*. This involves teaching C Language and implementation of some usual numeric methods, 24h.

2015 Plenary lectures in the Automatic Control Course of Denis Arzelier at ENSICA, Toulouse: *Automatique des systèmes linéaires (L2 level)*, 8h.

Conference Organization

- Organizer of Journées Nationales de Calcul Formel 2019, <http://www.jncf2019.uvsq.fr/>
- Organized the Symbolic-Numeric Session of SEAMAC Days: 2 days of seminars, talks and animation with MAC Team and invited speakers.
- Part of the Organization Committee of IFAC –International Federation of Automatic Control– 2017 World Congress which will take place in Toulouse.

Vulgarization:

Gave talks at Forum des Jeunes Mathématicien-ne-s in 2010 and 2013, see also [29, 28]: broad audience, intended for promoting, encouraging, emphasizing the participation of women in Mathematics. Organizer in 2018 of a meeting with winner students of Alkindi contest <http://www.concours-alkindi.fr/#/>