



Leonardo Robol

Curriculum Vitae

Personal data

- o Born on May, 2, 1988 in Rovereto (TN), Italy.

Academic positions

- 2018 – Now **Researcher.**
Department of Mathematics, University of Pisa, Italy.
November, 5, 2018 – current position.
- 2017 – 2018 **Researcher.**
ISTI, Area della Ricerca CNR, Pisa, Italy.
April, 3, 2017 – November, 2, 2018.
- 2015 – 2017 **Postdoc researcher.**
Department of Computer Science, KU Leuven, Belgium.
November, 2, 2015 – March, 31, 2017.
- 2011 – 2012 **Research scholarship.**
Scholarship on the study of numerical methods for the computation of the zeros of matrix and scalar polynomials at arbitrary precision and their implementation.
March, 1, 2011 – February, 29, 2012.

Education

- 2012 – 2015 **PhD in Mathematics, *Scuola Normale Superiore, Pisa, Italy.***
Thesis Exploiting rank structures for the numerical treatment of matrix polynomials.
Advisor Prof. Dario A. Bini.
Date November, 30, 2015.
Final mark 70/70 cum laude.
- 2010 – 2012 **Master degree in Mathematics, *Università di Pisa, Italy.***
Thesis A rootfinding algorithm for polynomials and secular equations.
Advisor Prof. Dario A. Bini.
Date September, 17, 2012.
Final mark 110/110 cum laude.
- 2007 – 2010 **Bachelor degree in Mathematics, *Università di Pisa, Italy.***
Thesis Compressione di immagini mediante trasformata wavelet: l'algoritmo EZW.
Advisor Prof. Dario A. Bini.
Date September, 24, 2010.
Final mark 110/110 cum laude.

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

Research interests

- Analysis of **Toeplitz-like** matrices.
- Analysis of matrix polynomials and design of **structure-preserving** linearizations.
- **Approximate rank structures, quasiseparable** matrices, and **decay** properties.
- Efficient methods for the solution of large scale **matrix equations**.
- **Rootfinding methods** to approximate polynomials' roots. Design of efficient methods for particular classes of polynomials.
- Fast methods for the optimization and the analysis of **finite element** models arising from the study of masonry structures.

Teaching experience

2013 – 2017 **Exercise sessions.**

Exercise sessions at the Computer Science and Mathematics Department in Pisa, Italy:

- *Computational methods for Learning and Data Analysis* – Master degree
 - Academic year 2017 – 2018, 20 hours of exercise sessions.
- *Numerical analysis* – Bachelor degree
 - Academic year 2012 – 2013, 22 hours of exercise sessions.
 - Academic year 2013 – 2014, 22 hours of exercise sessions.
 - Academic year 2017 – 2018, 20 hours of exercise sessions.

2015 – 2016 **Exercise sessions.**

- *Numerical Linear Algebra* – Master degree, Computer Science Department, KU Leuven, Belgium
 - Academic year 2015 – 2016, 16 hours of exercise sessions.
 - Academic year 2016 – 2017, 16 hours of exercise sessions.

2014 – 2015 **Tutorato.**

- Complementi di analisi, Scuola Normale Superiore, Pisa.
 - Academic year 2013 – 2014, 1 hour per week (equivalent to approximately 35 hours).

Prizes and awards

2018 **YRA (Young Researcher Award).**

The ISTI Young Researcher Award (YRA) is an annual award that honors its staff of less than 35 years old for a distinct contribute to the Institute activity with their scientific production.

2017 **Honorable mention at the Householder symposium HHXX.**

Awarded for the PhD thesis.

International collaborators

- Jared L. Aurentz, Instituto de Ciencias Matemáticas, Spain.
- Fernando De Terán, Universidad Carlos III de Madrid, Spain.
- Daniel Kressner, EPFL, Lausanne, Switzerland.
- Thomas Mach, Nazarbayev University, Kazakhstan.
- Raf Vandebril, KU Leuven, Belgium.
- Paul Van Dooren, Université Catholique de Louvain, Belgium.
- David S. Watkins, Washington State University, WA, USA.

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

Memberships

- 2018 – Now **SIAM**.
Member of the Society for Industrial and Applied Mathematics.
- 2017 – Now **ILAS**.
Member of International Linear Algebra Society.
- 2013 – Now **GNCS / INdAM**.
Member of Gruppo Nazionale per il Calcolo Scientifico.

Other scientific activities

Conference and workshop organization

- 2018 **SIAM ALA 2018, Hong Kong**.
Organizer of the minisymposium “Recent applications of rank structures in matrix analysis”.
Research in pairs, Luminy, France.
Co-organizer of a ‘Research in pairs’ workshop at the CIRM in Luminy, titled “Fast solvers for fractional differential equations”.
- 2016 **ILAS 2016, Leuven, Belgium**.
Member of the local organizing committee.

Plenary lectures

1. **Householder symposium XX**, Blacksburg, VA, USA, 2017.
Fast and backward stable computation of the eigenvalues of matrix polynomials.

Invitation to conferences

2. **SIMAI 2018**, Rome, Italy, 2018.
A Krylov-based trust region scheme for model updating.
3. **Structured Matrices in Numerical Linear Algebra**, Cortona, Italy, 2017.
Backward error analysis for structured polynomial root-finders.
4. **ILAS 2017**, minisymposium “Matrix Polynomials”, Ames, Iowa, USA, 2017.
Fast and backward stable computation of the eigenvalues of matrix polynomials.
5. **CMMSE 2017**, minisymposium “Rank structured matrices: recent developments and new perspectives”, Cadiz, Spain, 2017.
Solving large scale quasiseparable Lyapunov equations.
6. **N2LA**, Luminy, France, 2016.
Fast and backward stable computation of the eigenvalues of matrix polynomials.
7. **ILAS 2016**, Leuven, Belgium, minisymposium “Polynomial and rational eigenvalue problems”, 2016.
A Framework for Structured Linearizations of Matrix Polynomials in Various Bases.
8. **Structured Matrix Days 2016**, Limoges, France, 2016.
A Framework for Structured Linearizations of Matrix Polynomials in Various Bases.
9. **Structured Matrix Computations with Applications**, Sanya, China, 2016.
Ehrlich–Aberth iteration for rank structured pencils.
10. **SIAM ALA 2015**, minisymposium “Polynomial eigenvalue problems”, Atlanta, USA, 2015.
A Diagonal Plus Low Rank Family of Linearizations for Matrix Polynomials.
11. **Congresso UMI 2015**, session on *Linear Algebra and Optimization*, Siena, Italy,

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

2015.
A new class of rank structured linearizations for matrix polynomials.
12. **IWOTA 2015**, session on *Structured linear algebra*, Tbilisi, Georgia, 2015.
Efficient cyclic reduction for QBDs with rank structured blocks.
 13. **SLA2014**, Kalamata, Greece, 2014.
Hessenberg reduction of diagonal plus low rank matrices.
 14. **Workshop on Nonlinear Eigenvalue Problems**, Manchester, UK, 2014.
Solving matrix polynomials of large degrees: some computational issues.
 15. **ILAS 2013**, Providence, Rhode Island, USA, 2013.
Solving secular and polynomial equations: a multiprecision algorithm.

Other conferences

16. **SIAM ALA 18**, Hong Kong, 2018.
Solving 2D fractional differential equations using rank-structured matrix equations.
17. **Due Giorni di Algebra Lineare 2018**, Padova, Italy, 2018.
A Krylov-based trust region scheme for model updating.
18. **METT 2017**, Pisa, Italy, 2017.
Off-diagonal singular values decay in cyclic reduction.
19. **Due Giorni di Algebra Lineare**, Como, Italy, 2017.
Decay bounds for the numerical quasiseparable preservation in matrix functions.
20. **ALAMA 2016**, León, Spain, 2016.
A Framework for Structured Linearizations of Matrix Polynomials in Various Bases.
21. **Journees Approximation 2016**, Lille, France, 2016.
22. **NETNA2015**, Falerna, Italy, 2015.
A new class of rank structured linearizations for matrix polynomials.
23. **Structured Matrix Days 2015**, Limoges, France, 2015.
Quasiseparable Hessenberg triangular reduction for some diagonal plus low rank matrices.
24. **GAMM 2015**, Lecce, Italy, 2015.
Hessenberg reduction of diagonal plus low rank matrices.
25. **ILAS 2014**, Seoul, South Korea, 2014.
A new class of block companion matrices related to matrix polynomials.
26. **SNC 2014**, Shanghai, China, 2014.
A multiprecision algorithm for the solution of polynomials and polynomial eigenvalue problems.
27. **Due Giorni di Algebra Lineare**, Rome, Italy, 2013.
Solving secular and polynomial equations: a multiprecision algorithm.

Summer schools

- 2013 **Gene Golub Summer School**, *Shanghai, China*.

Seminars

- 2018 **EPFL**, *Lausanne, Switzerland*.
Distance from rank-structured matrices.
- ICMAT**, *Madrid, Spain*.
Low-rank updates for linear matrix equations.
- 2017 **Max Planck Institutue for Plasma Physics**, *Munich, Germany*.
Solving PDEs using rank-structured matrix equations.

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

EPFL, Lausanne, Switzerland.

Backward error analysis for polynomial root-finders.

Dipartimento di Matematica, Pisa, Italy.

Backward error analysis for polynomial root-finders.

2016 **KU Leuven, Leuven, Belgium.**

A multiprecision algorithm for polynomial rootfinding

Université des Sciences et Technologies de Lille, Lille, France.

On the decay of the off-diagonal singular values in cyclic reduction.

2015 **KU Leuven, Leuven, Belgium.**

Solving polynomial eigenvalue problems (and other related issues).

2014 **KU Leuven, Leuven, Belgium.**

MPSolve: how it works.

Projects and Grants

2018 **Grant for Young Mobility.**

Grant by ISTI-CNR supporting research visits to the department of Computer Science at KU Leuven, Belgium.

2017 **Research in pairs.**

Grant for the project “Fast solvers for fractional differential equations”, requested to organize a workshop “Research in pairs” at CIRM in Luminy.

2017 **ProgettISTI.**

Principal investigator of a 1 year project funded by ISTI-CNR: “Tensor algorithms for performativity analysis of large systems”.

2016 – 2017 **C1 project / KU Leuven.**

Participation to the project “Inverse-free Rational Krylov Methods: Theory and Applications”

2015 – 2017 **Participation in INdAM/GNCS projects.**

- GNCS 2017 “Metodi numerici avanzati per equazioni e funzioni di matrici con struttura”
- GNCS 2016 “Equazioni e funzioni di matrici con struttura: analisi e algoritmi”;
- GNCS 2015 “Metodi numerici per autovalori e funzioni di matrici con strutture”;

Peer review

I have refereed papers for the following journals:

- Applied Mathematics and Computation.
- BIT Numerical Mathematics.
- Calcolo.
- Electronic Journal of Linear Algebra.
- Journal of Nonlinear Mathematical Physics.
- Journal of Numerical Mathematics.
- Linear Algebra and its Applications.
- Mathematics of Computations.
- Numerical Algorithms.
- Numerical Linear Algebra with Applications.
- SIAM Journal on Matrix Analysis and Applications.

Research visits

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

- 2018 **EPFL**, (1 week).
Visit to Daniel Kressner to collaborate on the design of fast methods for HSS matrices.
- ICMAT**, (10 days).
Workshop “Autumn of Eigenvalues” on fast methods for computing eigenvalues of rank structured matrices and rootfinding problems.
- KU Leuven**, (2 weeks).
Visit to Raf Vandebril to continue an ongoing collaboration on computing eigenpairs of matrix polynomials.
- Department of Mathematics, University of Essex**, (1 week).
Visit to Vanni Noferini to collaborate on the backward error analysis of structured root-finders.
- 2017 **Max Planck Institute for Plasma Physics**, (1 week).
Visit to Mariarosa Mazza to collaborate on solver for fractional order PDEs based on rank-structured matrix equations.
- EPFL**, (1 week).
Visit to Daniel Kressner to collaborate on the design of fast methods for rank-structured Lyapunov equations.
- KU Leuven**, (2 weeks).
Visit to Raf Vandebril to continue an ongoing collaboration on computing eigenpairs of matrix polynomials.
- 2016 **Lille**, (1 day).
Visit to Bernhard Beckermann to give a seminar in the Numerical analysis seminar series in Lille.
- Perugia**, (1 day).
Visit to continue an ongoing collaboration with B. Iannazzo, F. De Terán and F. Poloni.
- 2015 **Perugia**, (2 days).
Visit that started the collaboration with B. Iannazzo, F. De Terán and F. Poloni on the uniqueness of solutions for generalized Sylvester equations.
- 2014 **KU Leuven**, (1 week).
Visited Raf Vandebril in Leuven to start the collaboration on the topic of polynomial eigenvalue problems.

Foreign languages

Italian	Mother tongue	
English	C1 Level	<i>Fluent speaking and writing skills</i>

Publications

To see an up-to-date list of my publications, you can check my Google Scholar profile or my personal web page.

Google Scholar https://scholar.google.com/citations?user=j9WP_U4AAAAJ

Scopus <https://www.scopus.com/authid/detail.uri?authorId=55748770500>

Books

1. **Core-Chasing Algorithms for the Eigenvalue Problem**, J. L. Aurentz, T. Mach, L. Robol, R. Vandebril, D. S. Watkins, SIAM, 2018.

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

Journal papers

2. **Factoring block Fiedler Companion Matrices**, G. M. Del Corso, F. Poloni, L. Robol, R. Vandebril, to appear in a volume of the Springer INdAM series, 2018.
3. **Solving rank structured Sylvester and Lyapunov equations**, S. Massei, D. Palitta, and L. Robol, to appear in SIAM Journal on Matrix Analysis and Applications, 2018.
4. **Quasi-Toeplitz matrix arithmetic: a MATLAB toolbox**, D. A. Bini, S. Massei, and L. Robol, to appear in Numerical Algorithms, 2018.
5. **Fast and backward stable computation of roots of polynomials, Part II: general backward error analysis**, J. L. Aurentz, T. Mach, L. Robol, R. Vandebril, and D. S. Watkins, SIAM Journal on Matrix Analysis and Applications, 2018 — DOI: 10.1137/17M1152802.
6. **Fast and backward stable computation of the eigenvalues of matrix polynomials**, J. L. Aurentz, T. Mach, L. Robol, R. Vandebril, D. S. Watkins, Mathematics of Computation, 2018 — DOI: 10.1090/mcom/3338.
7. **On quadratic matrix equations with infinite size coefficients encountered in QBD stochastic processes**, D. A. Bini, S. Massei, B. Meini, L. Robol, Numerical Linear Algebra with Applications, in press — DOI: 10.1002/nla.2128.
8. **Solvability and uniqueness criteria for generalized Sylvester-type equations**, F. De Terán, B. Iannazzo, F. Poloni and L. Robol, Linear Algebra and its Applications, Volume 542, April 2018, Pages 501–521 — DOI: 10.1016/j.laa.2017.07.010.
9. **Efficient Ehrlich–Aberth iteration for finding intersections of interpolating polynomials and rational functions**, L. Robol and R. Vandebril, Linear Algebra and its Applications, Volume 542, April 2018, Pages 282–309 — DOI: 10.1016/j.laa.2017.05.010.
10. **On the decay of the off-diagonal singular values in cyclic reduction**, D. A. Bini, S. Massei and L. Robol, Linear Algebra and its Applications, Volume 519, 15 April 2017, Pages 27–53 — DOI: 10.1016/j.laa.2016.12.027.
11. **Fast Hessenberg reduction of some rank structured matrices**, L. Gemignani, L. Robol, SIAM Journal on Matrix Analysis and Applications, Volume 38 (2), 22 June 2017, Pages 574–598 — DOI: 10.1137/16M1107851.
12. **Efficient cyclic reduction for Quasi-Birth-Death problems with rank structured blocks**, D. A. Bini, S. Massei and L. Robol, Applied Numerical Mathematics, Volume 116, 30 June 2017, Pages 37–46 — DOI: 10.1016/j.apnum.2016.06.014.
13. **A framework for structured linearizations of matrix polynomials in various bases**, L. Robol, R. Vandebril and P. Van Dooren, SIAM Journal on Matrix Analysis and Applications, Volume 38 (1), 16 March 2017, Pages 188–216 — DOI: 10.1137/16M106296X.
14. **Decay bounds for the numerical quasiseparable preservation in matrix functions**, S. Massei and L. Robol, Linear Algebra and its Applications, Volume 516, 1 March 2017, Pages 212–242 — DOI: 10.1016/j.laa.2016.11.041.
15. **Quasiseparable Hessenberg reduction of real diagonal plus low rank matrices and applications**, D. A. Bini and L. Robol., Linear Algebra and Its Applications, Volume 502, 1 August 2016, Pages 186–213 — DOI: 10.1016/j.laa.2015.08.026.
16. **On a Class of Matrix Pencils Equivalent to a Given Matrix Polynomial**, D. A. Bini and L. Robol, Linear Algebra and Its Applications, Volume 502, 1 August 2016, Pages 275–298 — DOI: 10.1016/j.laa.2015.07.017.
17. **Solving secular and polynomial equations, a multiprecision algorithm**, D. A. Bini and L. Robol, Journal of Computational and Applied Mathematics, Volume 272, 15 December 2014, Pages 276–292 — DOI: 10.1016/j.cam.2013.04.037.

Proceedings

18. **Fea for masonry structures and vibration-based model updating using NOSA-ITACA**, M. Girardi, C. Padovani, D. Pellegrini, L. Robol, 10th International Masonry

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

7/9

- Conference, Milano, 9-11 July 2018.
19. **NOSA-ITACA: a free FE program for historic masonry buildings**, M. Girardi, C. Padovani, D. Pellegrini, L. Robol, CoRASS 2017 - ECCOMAS Conference on Recent Advances in Nonlinear Models - Design and Rehabilitation of Structures (Coimbra, Portugal, 16-17 November 2017) — ISBN: 978-989-96461-8-6.
 20. **A multiprecision algorithm for the solution of polynomials and polynomial eigenvalue problems**, D. A. Bini, L. Robol, Proceedings of the 2014 Symposium on Symbolic-Numeric Computation Pages 17-18, 28 July 2014 — ISBN: 978-1-4503-2963-7.

Under review

21. **Fast solvers for 2D fractional diffusion equations using rank structured matrices**, M. Mazza, S. Massei, and L. Robol, arXiv preprint arXiv:1804.05522.
22. **Computing performability measures in Markov chains by means of matrix functions**, G. Masetti, and L. Robol, arXiv preprint arXiv:1803.06322.
23. **Finite element model updating for structural applications**, M. Girardi, C. Padovani, D. Pellegrini, L. Robol, arXiv preprint arXiv:1801.09122.
24. **Low-rank updates and a divide-and-conquer method for linear matrix equations**, D. Kressner, S. Massei, and L. Robol, arXiv preprint arXiv:1712.04349, 2017.
25. **Nonsingular systems of generalized Sylvester equations: an algorithmic approach**, F. De Terán, B. Iannazzo, F. Poloni and L. Robol, arXiv preprint arXiv:1709.03784, 2017.

Technical reports

26. **Analyzing a security and reliability model using Krylov methods and matrix functions**, G. Masetti, L. Robol, ISTI-CNR Technical Report, 2018.
27. **Fast and backward stable computation of roots of polynomials, Part IIa: general backward error analysis**, J. L. Aurentz, T. Mach, L. Robol, R. Vandebriel, and D. S. Watkins, Report TW 683, KU Leuven, 2017.
28. **NOSA-ITACA 1.1 documentation**, V. Binante, M. Girardi, C. Padovani, G. Pasquinelli, D. Pellegrini, M. Porcelli, L. Robol, ISTI-2017-SW-013, 2017.
29. **Certified counting of roots of random univariate polynomials**, J. Cleveland, J. Dzugan, J. D. Hauenstein, I. Haywood, D. Mehta, A. Morse, L. Robol, and T. Schlenk, arXiv:1412.1717, 2014.

Theses

30. **Exploiting rank structures for the numerical treatment of matrix polynomials**, L. Robol, PhD thesis, Scuola Normale Superiore di Pisa, 2015.
31. **A rootfinding algorithm for polynomials and secular equations**, L. Robol, Master thesis, Università di Pisa, 2012.
32. **Compressione di immagini mediante trasformata wavelet: l'algoritmo EZW**, L. Robol, Bachelor thesis, Università di Pisa, 2010.

Software

I developed and contributed to a wide range of software. Most of my contributions are available on my Github page at <https://github.com/robo1>.

Via Amerigo Vespucci, 34 – 56125 Pisa, Italy

☎ (+39) 346 3034222 • ✉ leonardo.robol@isti.cnr.it

🌐 leonardo.robol.it

- 2011 – Now **MPSolve**, *multiprecision polynomial solver that computes the roots of univariate polynomial at arbitrary precision*, The project is written in C/C++, and it amounts to more than 50k LOC. The code is open source and available at <http://numpi.dm.unipi.it/software/mpsolve/>. Bindings for several languages (Python, MATLAB, Octave, Fortran, ...), a desktop user interface, and an Android app are available. The implementation relies on pthreads for parallelism.
- 2015 – Now **h2lib-matlab**, *a MATLAB interface to the H2Lib library*, <https://github.com/robol/h2lib-matlab/>.
- 2017 – Now **cqt-toolbox**, *a MATLAB toolbox to compute with infinite Toeplitz matrices with finite corrections*, <https://github.com/numpi/cqt-toolbox/>.
- 2017 – Now **hm-toolbox**, *a MATLAB toolbox to compute with Hierarchical matrices and HSS, and to solve some kinds of matrix equations*, <https://github.com/numpi/hm-toolbox/>.
- 2017 – Now **NOSA**, *a finite element code for masonry-like structures, with modules for static, dynamic, and modal analysis, as well as support for advanced model updating features*, <http://www.nosaitaca.it/>.