

Théo Mary | PhD

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Work experience

Research Associate

University of Manchester – School of Mathematics

Manchester, UK

Jan. 2018–ongoing

- *Supervisor:* Nicholas Higham.
 - *Description:* I am part of the **ICONIC** project, which aims to develop theory, methodology, and algorithms to propagate uncertainty in mathematical models of socio-economic phenomena in future cities. My work focuses on the numerical aspects of the project.
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Collaboration with the **MUMPS** team

Toulouse INP

Toulouse, France

Oct. 2017–ongoing

In continuation of my PhD thesis work, I collaborate with the MUMPS team on the design of Block Low-Rank multifrontal solvers.

PhD doctorate in Computer Science and Applied Mathematics

Université de Toulouse (**UPS**) – **IRIT** laboratory

Toulouse, France

Oct. 2014–Sep. 2017

- *Title:* Block Low-Rank multifrontal solvers: complexity, performance, and scalability.
 - *Date of award:* 24 November 2017.
 - *Advisors:* Patrick Amestoy and Alfredo Buttari.
 - *Description:* I investigated the use of low-rank approximation techniques to improve the computational cost of multifrontal solvers, in terms of theoretical complexity, memory consumption, and gains in run time on shared- and distributed-memory architectures.
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3 month visit in Sherry Li's group

Lawrence Berkeley National Laboratory (**LBNL**)

Berkeley, CA, USA

Feb.–Apr. 2017

Collaboration on the comparison of BLR and HSS low-rank formats in multifrontal solvers.

Collaboration with the **SEISCOPE** consortium

Geoazur institute and Université Grenoble Alpes (**UGA**)

Nice & Grenoble, France

2014–ongoing

Application of a BLR multifrontal solver to real-life seismic modeling problems.

6 month research internship in Jack Dongarra's lab

Innovative Computing Laboratory (**ICL**), University of Tennessee

Knoxville, TN, USA

Mar.–Aug. 2014

- *Topic:* Randomized algorithms for computing low-rank approximations of dense matrices on multicore+GPUs architectures.
- *Advisor:* Ichitaro Yamazaki.

Education

UPS-IRIT

PhD degree in Computer Science and Applied Mathematics

Toulouse, France

2014–2017

ENSEEIH

French diploma of engineering, equivalent to master's degree

Department of Computer Science and Applied Mathematics

Toulouse, France

2011–2014

Lycée Pierre de Fermat

Classes Préparatoires aux Grandes Ecoles

Toulouse, France

2009–2011

Lycée Français de Barcelone

Baccalaureate of Science

Barcelona, Spain

2009

Software

MUMPS

MUMPS is a parallel, direct solver for sparse linear systems. Being designed for distributed memory computing environments, MUMPS is based on MPI and has a wide range of features that make it reliable and efficient. MUMPS is currently used in several industrial and academic applications and has thousands of users worldwide. I am working on the Block Low-Rank (BLR) feature of MUMPS to improve the computational cost (time, flops and memory) of the solver.

Teaching

During my PhD from 2014 to 2017, I was involved in teaching activities at the Toulouse INP-**ENSEEIH** engineering school. I taught over 200 hours as teaching assistant in the following courses:

- Numerical Linear Algebra (2014–2017, 65 hours)
- Graph Theory (2014–2017, 46 hours),
- Numerical Analysis (2015–2017, 36 hours)
- Parallel Computing (2015–2017, 24 hours)
- Distributed Computing (2015–2017, 24 hours)
- Imperative Programming (2014–2015, 12 hours)
- Sparse Linear Algebra (2017, 2 hours)

I was also involved in the creation and supervision of the student project assignments:

- Model reduction approaches for PDE problems (Numerical Linear Algebra course)
- Task scheduling on directed acyclic graphs (Graph Theory course)

Finally, in fall 2017, I co-created and co-taught with P. Amestoy and A. Buttari the course "Large-scale sparse linear algebra".

Publications

PhD Thesis

T. MARY, *Block Low-Rank multifrontal solvers: complexity, performance, and scalability*, PhD thesis, Université de Toulouse, November 2017.

International Journal Articles (Submitted)

P. R. AMESTOY, A. BUTTARI, J.-Y. L'EXCELLENT, AND T. MARY, *Bridging the gap between flat and hierarchical low-rank matrix formats: the multilevel BLR format*, SIAM Journal on Scientific Computing. Submitted (2018).

——, *Performance and Scalability of the Block Low-Rank Multifrontal Factorization on Multicore Architectures*, ACM Transactions on Mathematical Software. Submitted (2017).

N. J. HIGHAM AND T. MARY, *A New Preconditioner that Exploits Low-Rank Approximations to Factorization Error*, SIAM Journal on Scientific Computing. Submitted (2018).

International Journal Articles.....

P. R. AMESTOY, R. BROSSIER, A. BUTTARI, J.-Y. L'EXCELLENT, T. MARY, L. MÉTIVIER, A. MINIUSI, AND S. OPERTO, *Fast 3D frequency-domain full waveform inversion with a parallel Block Low-Rank multifrontal direct solver: application to OBC data from the North Sea*, Geophysics, 81 (2016), pp. R363 – R383.

P. R. AMESTOY, A. BUTTARI, J.-Y. L'EXCELLENT, AND T. MARY, *Performance and Scalability of the Block Low-Rank Multifrontal Factorization on Multicore Architectures*, ACM Transactions on Mathematical Software. To appear, 2018.

——, *On the Complexity of the Block Low-Rank Multifrontal Factorization*, SIAM Journal on Scientific Computing, 39 (2017), pp. A1710–A1740.

D. V. SHANTSEV, P. JAYSAVAL, S. DE LA KETHULLE DE RYHOVE, P. R. AMESTOY, A. BUTTARI, J.-Y. L'EXCELLENT, AND T. MARY, *Large-scale 3D EM modeling with a Block Low-Rank multifrontal direct solver*, Geophysical Journal International, 209 (2017), pp. 1558 – 1571.

International Conferences and Workshops with Proceedings.....

P. R. AMESTOY, R. BROSSIER, A. BUTTARI, J.-Y. L'EXCELLENT, T. MARY, L. MÉTIVIER, A. MINIUSI, S. OPERTO, A. RIBODETTI, J. VIRIEUX, AND C. WEISBECKER, *Efficient 3D frequency-domain full-waveform inversion of ocean-bottom cable data with sparse block low-rank direct solver: a real data case study from the North Sea*, in International Conference Society of Exploration Geophysicists (SEG) Annual Meeting, New Orleans, USA, October 2015.

P. R. AMESTOY, R. BROSSIER, A. BUTTARI, J.-Y. L'EXCELLENT, T. MARY, L. MÉTIVIER, A. MINIUSI, S. OPERTO, J. VIRIEUX, AND C. WEISBECKER, *3D frequency-domain seismic modeling with a Parallel BLR multifrontal direct solver*, in International Conference Society of Exploration Geophysicists (SEG) Annual Meeting, New Orleans, USA, October 2015.

T. MARY, I. YAMAZAKI, J. KURZAK, P. LUSZCZEK, S. TOMOV, AND J. DONGARRA, *Performance of Random Sampling for Computing Low-rank Approximations of a Dense Matrix on GPUs*, in SC'15 - International Conference for High Performance Computing, Networking, Storage and Analysis, Austin, USA, November 2015.

I. YAMAZAKI, T. MARY, J. KURZAK, S. TOMOV, AND J. DONGARRA, *Access-averse framework for computing low-rank matrix approximations*, in 2014 IEEE International Conference on Big Data, Washington, USA, October 2014.

International Conferences and Workshops without Proceedings.....

P. R. AMESTOY, J. ANTON, C. ASHCRAFT, A. BUTTARI, P. GHYSELS, J.-Y. L'EXCELLENT, X. S. LI, T. MARY, F.-H. ROUET, AND C. WEISBECKER, *A comparison of parallel rank-structured solvers*, in SIAM Conference on Parallel Processing (SIAM PP'16), Paris, France, April 2016.

P. R. AMESTOY, C. ASHCRAFT, A. BUTTARI, P. GHYSELS, J.-Y. L'EXCELLENT, X. S. LI, T. MARY, F.-H. ROUET, AND C. WEISBECKER, *A comparison of different low-rank approximation techniques*, in SIAM Conference on Applied Linear Algebra (SIAM LA'15), Atlanta, USA, October 2015.

P. R. AMESTOY, A. BUTTARI, P. GHYSELS, J.-Y. L'EXCELLENT, X. S. LI, T. MARY, AND F.-H. ROUET, *Comparison of BLR and HSS low-rank formats in multifrontal solvers: theory and practice*, in SIAM Conference on Computational Science and Engineering (SIAM CSE'17), Atlanta, USA, February 2017.

P. R. AMESTOY, A. BUTTARI, J.-Y. L'EXCELLENT, AND T. MARY, *Complexity and performance of Block Low-Rank multifrontal factorization and its variants*, in SIAM Conference on Parallel Processing (SIAM PP'16), Paris, France, April 2016.

———, *On the complexity of the Block Low-Rank multifrontal factorization*, in Sparse Days, Toulouse, France, June 2016.

———, *Performance and scalability of the Block Low-Rank multifrontal factorization*, in Parallel Matrix Algorithms and Applications (PMAA'16), Bordeaux, France, July 2016.

———, *Sparse direct solvers towards seismic imaging of large 3D domains*, in 78th EAGE Conference, workshop methods and challenges of seismic wave modelling for seismic imaging, Vienna, Austria, June 2016.

———, *Block Low-Rank multifrontal solvers: complexity, performance, and scalability*, in Sparse Days, Toulouse, France, September 2017.

———, *Block Low-Rank multifrontal sparse direct solvers*, in Mathias 2017, Paris, France, October 2017.

———, *Bridging the gap between flat and hierarchical low-rank matrix formats*, in Structured Matrix Days), Lyon, France, May 2018.

———, *Distributed-memory Block Low-Rank multifrontal factorization for large scale systems and applications*, in SIAM Conference on Parallel Processing (SIAM PP'18), Tokyo, Japan, March 2018.

T. MARY, I. YAMAZAKI, J. KURZAK, P. LUSZCZEK, S. TOMOV, AND J. DONGARRA, *Performance of Random Sampling for Computing Low-rank Approximations of a Dense Matrix on GPUs*, in SIAM Conference on Computational Science and Engineering (SIAM CSE'15), Salt Lake City, USA, March 2015.

THE MUMPS TEAM, *Improving multifrontal solvers by means of Block Low-Rank approximations*, in CIMI HPC semester: workshop on fast solvers, Toulouse, France, June 2015.

I. YAMAZAKI, T. MARY, J. KURZAK, S. TOMOV, AND J. DONGARRA, *Performance of Computing Low-Rank Approximation on Hybrid CPU/GPU Architectures*, in SIAM Conference on Computational Science and Engineering (SIAM CSE'15), Salt Lake City, USA, March 2015.