Bastien VIEUBLÉ

Research Associate

> *My research focuses on using approximate computing techniques for the ease of high performance linear algebra algorithms. I attach great importance to covering the algorithms from a theory-focused standpoint to their implementation on parallel supercomputers for the solution of academic and industrial applications. In particular, I extensively worked on mixed precision iterative refinement, which is the core algorithm of my Ph.D. thesis.*
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> *Last update: February 2, 2024*

Education

Ph.D.
Oct. 2019 – Oct. 2022
INPT-IRIT, Toulouse, France

Mixed precision iterative refinement for the solution of large sparse linear systems. My Ph.D. thesis research includes the following:

- Improvement of direct and iterative solvers for the solution of linear systems with approximate computing techniques.
- Rounding error analysis of mixed precision algorithms.
- Parallel implementation and performance analysis of mixed precision algorithms on parallel supercomputers using academic and industrial applications.

Advisors: Alfredo BUTTARI, Théo MARY

M.Eng. and M.Sc. in Comp. Sc. and Applied Math.
Sep. 2015 – Sep. 2019
ENSEEIHT, Toulouse, France

High Performance Computing and Big Data department. Sample of the courses:

- Cloud computing
- Scientific computing
- PDE
- Parallel computing
- Operating system
- Data analysis and ML
- Sparse direct solver
- Image processing

Preparatory classes
Sep. 2013 – Aug. 2015
Lycée Descartes, Tours, France

Mathematics and Physics department. Two-year undergraduate intensive courses in mathematics and physics.

Research Experience

Research Associate
Nov. 2022 – Now
The University of Manchester, Manchester, UK

Member of the Numerical Linear Algebra group working with Pr. Nicholas J. HIGHAM. My research topics cover sparse direct and iterative solvers, high performance computing, rounding error analysis, mixed precision, and approximate computing.

Visit to the NLA group
Mar. 2022 – May 2022
The University of Manchester, Manchester, UK

Three months visit to the NLA group at the University of Manchester during my Ph.D. thesis for an international collaboration with Pr. Nicholas J. HIGHAM.

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Internship
Apr. 2019 – Sep. 2019
AMSS, Beijing, China

Deep learning approaches to determine the dominant eigenvalues. Study of the sparse matrix case using graph neural network approaches with TensorFlow.

Advisor: Pr. Xin Liu

Group project
Jan. 2019 – Mar. 2019
ENSEEIHT, Toulouse, France

Supervised postgraduate group project. Use of convolutional neural networks to estimate the nearshore bathymetry through wave motions. This work contributed to a journal article.

Advisor: Ehouarn SIMON

Gap year
Sep. 2017 – Sep. 2018
IPAL-CNRS, Singapore

Position tracking of fingers on a large 2D surface. Part of a project willing to make wearable technology to help visually impaired people to interact with maps. Different technologies were used: Inertial Measurement Unit (IMU), color tracking, Leap Motion, and the creation of a dot patterns based finger tracker inspired by the Anoto technology.

Advisor: Christophe JOUFFRAIS

Journal Articles

Combining sparse approximate factorizations with mixed precision iterative refinement
2022, ACM Trans. Math. Softw.
P. Amestoy, A. Buttari, N. J. Higham, J. l'Excellent, T. Mary, and **B. Vieublé**

This paper investigates the use of mixed precision iterative refinement with approximate factorization techniques for the improvement of direct parallel sparse solvers. It first adapted the error analysis of LU- and GMRES-based iterative refinement with a model closer to practical uses of sparse solvers (e.g., with the use of approximate factorizations). In a second time, it developed a performance analysis of these algorithms on large sparse problems coming from a variety of real-life and industrial applications. It highlighted significant gains in time and memory while ensuring great accuracy and robustness on the problem conditioning.

Five-Precision GMRES-based iterative refinement
2021, To be published in SIAM SIMAX
P. Amestoy, A. Buttari, N. J. Higham, J. l'Excellent, T. Mary, and **B. Vieublé**

This paper extends the GMRES-based iterative refinement method in three precisions which can handle much more ill-conditioned problems than traditional iterative refinement. It presents a variant of this method where requirements on the precisions used within GMRES are relaxed, which leads to a five-precision GMRES-based iterative refinement algorithm. We present a theoretical analysis of the resulting algorithm and define the conditions under which it is guaranteed to converge. It also includes a large experimental section to assess the theoretical findings.

A Deep Learning Approach for Estimation of the Nearshore Bathymetry
2020, J. of Coastal Research
R. Benshila, G. Thoumyre, M. Al Najar, G. Abessolo, R. Almar, E. Bergsma, G. Hugonnard, L. L., Benjamin Lavie, T. Ragonneau, E. Simon, **B. Vieublé**, and D. Wilson

Bathymetry is an important factor in determining wave and current transformation in coastal and surface areas but is often poorly understood. However, its knowledge is crucial for hydro-morphodynamic forecasting and monitoring. Available for a long time only via in-situ measurement, the advent of video and satellite imagery has allowed the emergence of inversion methods from surface observations. With the advent of methods and architectures adapted to big data, a treatment via a deep learning approach seems now promising. This paper provides a first overview of such possibilities with synthetic cases and its potential application on a real case.

Talks in international conferences

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MUMPS User Days
Jun. 2023
Paris, France

A new backward error analysis framework for GMRES and its application to GMRES preconditioned with MUMPS in mixed precision.

FoCM
Jun. 2023
Paris, France

A new backward error analysis framework for GMRES. In the "Numerical Linear Algebra" workshop.

Sparse Days
Jun. 2022
St-Girons, France

Mixed precision strategies for preconditioned GMRES. In the "Low rank approximation, variable precision, randomization II" session.

ISC High Performance
May 2022
Hamburg, Germany

Combining sparse approximate factorizations with mixed precision iterative refinement. In the "Mixed Precision in Low-Rank Approximation and Randomization" focus session.

SIAM PP
Feb. 2022
Virtual

Mixed Precision Iterative Refinement with Approximate Factorization for the Solution of Large Sparse Systems. In the "Approximate Computing for Scientific Applications: The Why and The How - Part II of III (MS26)" minisymposium.

CJC-MA
Oct. 2021
Massy-Palaiseau, France

Modern iterative refinement methods for the solution of large sparse linear systems. In the "Analyse numérique 1" session.

RAIM
May 2021
Virtual

Modern iterative refinement methods for the solution of large sparse linear systems. In the 4th session.

SIAM CSE
Mar. 2021
Virtual

GMRES-based iterative refinement in up to five precisions. In the " Mixed Precision Algorithms for High Performance Scientific Computing - Part II of II (MS223)" minisymposium.

WCCM-ECCOMAS
Jan. 2021
Virtual

Mixed precision iterative refinement for the solution of large sparse linear systems.

Sparse Days
Nov. 2020
Virtual

Multiple precisions iterative refinement for the solution of large sparse linear systems. In the 3rd session.

Teaching Experience

Lecture, mixed precision
Feb. 2023 and Jan. 2024
Université Paris-Saclay, France

Design and delivery of a 1-hour lecture in English to postgraduate students on mixed precision iterative refinement.

Lecture, insight of my Ph.D.
Feb. 2022
HPC M.Sc. seminar, France

A 1-hour talk about my Ph.D. research topic to postgraduate students specialized in high performance computing from many french universities.

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Lab class, graph theory
2019 – 2022
ENSEEIHT, Toulouse, France

Design, marking, organization, and delivery of two student code projects: "Communities detection" and "Epidemic spreading". Approximately 8 hours of class each.

Lab class, parallel computing
2019 – 2022
ENSEEIHT, Toulouse, France

Delivery of OpenMP and MPI based lab work classes to parallelize simple applications. Design of a 2-hours lab work class part of this teaching unit: "Heterogenous matrix–matrix product with CPU and GPU".

Lab/Tutorial class, scientific computing
2019 – 2022
ENSEEIHT, Toulouse, France

Delivery of tutorial and lab work classes to introduce mainstream linear algebra algorithms (direct or iterative linear system solvers, eigenvalues computation, numerical error, etc.).

Lab class, data analysis
2020 – 2021
ENSEEIHT, Toulouse, France

Delivery of lab work classes to introduce mainstream data analysis algorithms (SVM, PCA, k-nearest neighbors algorithm, etc.).

Grants and awards

Leopold Escande prize
Sep. 2023
INP Toulouse

Prize awarded to the 15% best thesis of INP Toulouse for the scientific excellence and the originality of the work.

MESRI doctoral contract
Oct. 2019 – Oct. 2022
French government funding

Government funding covering my wage over the three years of Ph.D. thesis. Obtained after competitive examination.

International travel grant
Mar. 2022 – May. 2022
INPT/CIMI

Awarded to cover expenses for a three months mission at the University of Manchester for a collaboration with Pr. Nicholas J. HIGHAM.

Service to field

Reviewer

Peer reviews for the *Numerical linear algebra with applications* journal and the *Platform for Advanced Scientific Computing (PASC23)* conference.

Volunteering

Volunteering for the sparse days 2022 conference happening in St-Girons.

Seminar

Co-organization of a PhD students seminar at IRIT. Co-organization of the SIAM student chapter conference at the University of Manchester (10 talks from students and invited speakers spread throughout a full day).

Minisymposium

Co-organization of the minisymposium "Approximate Computing in Numerical Linear Algebra" in the Biennial Numercial Analysis conference in Glasgow 2023 (Co-organizers: Xiaobo LIU and Nicholas J. HIGHAM).

Communication to companies

My Ph.D. thesis was strongly correlated with the MUMPS software used by many important international companies (EDF, Michelin, ANSYS, SHELL, etc.). I gave and attended different talks during workshops organised by MUMPS Tech. in front of representatives of these companies.

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