Oleg Balabanov

Research Scientist, PhD

Nationality: Ukrainian
Location: San Francisco Bay Area
✉ olegbalabanov@gmail.com

8 years of experience in defining and leading research in randomized numerical methods for machine learning and scientific computing. Possess international and multidisciplinary professional background. Worked on large interdisciplinary projects. Developed innovative algorithms for classical and modern architectures. Possess substantial mathematical apparatus and excellent coding and communication skills.

Research Disciplines

- Numerical Analysis • Large-Scale Numerical Modeling & Optimization • Machine Learning
- Randomized Linear Algebra • Model Order Reduction

Experience

Aug, 2023 – Present

Research Scientist
University of California, Berkeley & Lawrence Berkeley National Laboratory & International Computer Science Institute, United States
Department of Statistics, Michael Mahoney's Bid Data and Machine Learning group

- Working on National Science Foundation projects:
  - Scalable Second-Order Methods for Training, Designing, and Deploying Machine Learning Models
  - Collaborative Research: Scalable Linear Algebra and Neural Network Theory
  - Basic Algebra Libraries for Sustainable Technology with Interdisciplinary Collaboration
- Developing randomized numerical methods for scientific machine learning, computational mechanics & statistics, large-scale optimization and data analysis.
- Supervising a research engineer developing the C++ RandLAPACK library.
- Leading a capstone project for MEng students called "Teaching Large-Language Models to Discover Machine Learning Algorithms".
- Supervised a summer research project for a Department of Energy graduate fellow, focused on enhancing kernel ridge regression and logistic regression using randomized preconditioning methods.

Nov, 2019 – June, 2022

Research Scientist
National Institute for Research in Digital Science and Technology & Sorbonne Université, France
Laboratoire Jacques-Louis Lions, Laura Grigori's ALPINES group

- Worked on "Extreme-scale Mathematically-based Computational Chemistry" project developing new generation, dramatically faster and quantitatively reliable molecular simulation software, erc-emc2.eu.
- Led a local research team in randomized numerical methods consisting of a software engineer, a PhD student, and myself.
- Developed advanced randomized algorithms for solving large-scale linear systems and eigenproblems on classical and modern architectures. Enhanced numerical simulations with latest computational tools such as Randomized Singular Value Decomposition.
- Collaborated with researchers across disciplines on molecular simulations and modern quantum chemistry.
- Produced high quality reports/presentations/publications/code. Supervised a software engineer to produce an efficient parallel linear solver with Julia, C and MPI.

Oct, 2015 – Oct, 2019

PhD Researcher
Centrale Nantes, France & Universitat Politècnica de Catalunya, Spain
Laboratoire de Mathématiques Jean Leray, in collaboration with Centro Internacional de Métodos Numéricos en la Ingeniería

• Conducted research in numerical simulations and model order reduction.
• Developed innovative randomized algorithms suited for classical and modern architectures that can be used for real-time simulations, design, optimization, and quantification of uncertainties.
• Produced high quality reports/presentations/publications/code.

May, 2014 – **Research Engineer**
Sep, 2014 *Silvaco Inc, United Kingdom*

• Conducted multidisciplinary research in solid state physics and computational mechanics.
• Produced a C++ extension for a finite element tool Victory Stress (now part of Victory TCAD Process) to simulate the Raman effect.

Education

2015 – 2019 **PhD Applied Mathematics, summa cum laude**
Centrale Nantes & Universitat Politecnica de Catalunya, France & Spain
Directors: Anthony Nouy & Nuria Pares Marine
Distinction

2013 – 2015 **MSc Computational Mechanics**
Universitat Politecnica de Catalonia & Swansea University, Spain & United Kingdom
Distinction

2009 – 2013 **BSc Applied Mathematics & BSc Electrophysics**
National Chiao Tung University, Taiwan
Two full degrees
Distinction

Skills

Programming Python, Julia, Matlab, LaTeX, Git, Scipy, PyTorch, LAPACK, BLAS, Distributed Computing, Low-Precision Arithmetic.

Methods Randomization, Numerical Linear Algebra, Numerical Optimization, Dimensionality Reduction, High-Dimensional Probability, Stability Analysis, Approximation Theory, Big Data, Krylov Methods, Regression Analysis, Principal Component Analysis, Kernel Methods, Numerical Methods for PDEs, Finite Element Analysis.

Languages English, Ukrainian, Russian, French (reading).

Soft Leadership, Teamwork, Proactivity.

Software

RandKrylov: *randomized MATLAB linear solvers that provide up to 4x and 10x speedups over built-in* `gmres` *and* `eigs` *solvers.*
github.com/obalabanov/randKrylov

RandLAPACK: *open-source C++ library, delivering portable, highly optimized and scalable randomized routines for common large-scale linear algebra problems. In progress.*
github.com/BallisticLA/RandLAPACK

Fellowships & Awards

2015 – 2018 *Category A Fellowship of The Joint Doctorate in Simulation in Engineering and Entrepreneurship Development,* European Commission.

2013 – 2015 *Category A Stipend for Masters in Computational Mechanics,* European Commission.

2009 – 2013 *Golden Bamboo Award Stipend,* National Chiao Tung University.

Publications

Journal Articles

2024 Oleg Balabanov and Laura Grigori. Randomized Block Gram-Schmidt Process for the Solution of Linear Systems and Eigenvalue Problems. *arXiv preprint arXiv:2111.14641, Accepted for publication in SIAM Journal on Scientific Computing*. SIAM, 2024.

2022 Oleg Balabanov and Laura Grigori. Randomized Gram–Schmidt Process with Application to GMRES. *SIAM Journal on Scientific Computing*, volume 44, pages A1450–A1474. SIAM, 2022.

2021 Oleg Balabanov and Anthony Nouy. Randomized Linear Algebra for Model Reduction. Part II: Minimal Residual Methods and Dictionary-based Approximation. *Advances in Computational Mathematics*, volume 47, pages 1–54. Springer, 2021.

2019 Oleg Balabanov and Anthony Nouy. Randomized Linear Algebra for Model Reduction. Part I: Galerkin Methods and Error Estimation. *Advances in Computational Mathematics*, volume 45, pages 2969–3019. Springer, 2019.

Conference Articles

2023 Oleg Balabanov, Matthias Beaupère, Laura Grigori, and Victor Lederer. Block Subsampled Randomized Hadamard Transform for Nyström Approximation on Distributed Architectures. *International Conference on Machine Learning*, pages 1564–1576, 2023.

Technical Reports and Preprints

2023 Edouard Timsit, Laura Grigori, and Oleg Balabanov. Randomized Orthogonal Projection Methods for Krylov Subspace Solvers. *arXiv preprint arXiv:2302.07466*, 2023.

2023 Maksim Melnichenko, Oleg Balabanov, Riley Murray, James Demmel, Michael W Mahoney, and Piotr Luszczek. CholeskyQR with Randomization and Pivoting for Tall Matrices (CQRRPT). *arXiv preprint arXiv:2311.08316*, 2023.

2022 Oleg Balabanov. Randomized Cholesky QR Factorizations. *arXiv preprint arXiv:2210.09953*, 2022.

2021 Oleg Balabanov and Anthony Nouy. Preconditioners for Model Order Reduction by Interpolation and Random Sketching of Operators. *arXiv preprint arXiv:2104.12177*, 2021.

PhD Dissertation

2019 Oleg Balabanov. *Randomized Linear Algebra for Model Order Reduction*. PhD thesis, Centrale Nantes; Universitat Politècnica de Catalunya, 2019.

Talks

May, 2024 Organizer and speaker at session "Approximate Computing Techniques for Orthogonalization Processes", *SIAM Conference on Applied Linear Algebra*, Paris, France.

Feb, 2024 "Randomized numerical linear algebra for large-scale parametric model order reduction", *ICME Linear Algebra and Optimization Seminar*, Stanford University, United States.

Feb, 2023 "Randomized Krylov methods for solution of linear systems and eigenproblems", *Seminar on Numerical Analysis and Scientific Computing*, University of Manchester, United Kingdom.

May - June, 2022 Speaker at session "Mixed Precision in Low-Rank Approximation and Randomization", *ISC High Performance*, Hamburg, Germany.

May, 2021 "Randomized linear algebra for model order reduction", *SimTech Seminar on Model Reduction and Data Techniques for Surrogate Modelling*, University of Stuttgart, Germany.

July, 2020 Speaker at session "Complexity reduction methods", *International Conference on Spectral and High Order Methods*, Vienna, Austria.

July, 2019 Speaker at session "New trends in dimensionality reduction of parametrized and stochastic PDEs", *9th International Congress on Industrial and Applied Mathematics*, Valencia, Spain.

Feb - Mar, 2019	Speaker at session "New challenges and opportunities for Model Order Reduction", *SIAM Conference on Computational Science and Engineering*, Spokane, USA.
Sep, 2018	"Dictionary-based Model Order Reduction via random sketching", *Model Order Reduction Workshop*, Hamburg, Germany.
Apr, 2018	"Random sketching for model order reduction", *4th Conference on Model Reduction of Parametrized Systems*, Nantes, France.
Sep, 2017	"Random sketching for model order reduction", *Reduced Basis Workshop*, Goslar, Germany.
Feb – Mar, 2017	Speaker at session "Smooth, reduced, sparse – Exploiting structures for surrogate modeling in CSE", *SIAM Conference on Computational Science and Engineering*, Atlanta, USA.
June – July, 2016	"Random sketching for model order reduction", *CISM-ECCOMAS International Workshops*, Udine, Italy.