Alexey Voronin

axvsim@proton.me alexey-voronin.github.io Alexey-Voronin axvoronin

EDUCATION

University of Illinois at Urbana-Champaign *Aug 2018 - May 2024 (expected)*
Doctor of Philosophy (Ph.D.) in Computer Science
· Thesis Title: Algebraic Multigrid Methods for Numerical Solution of Saddle-Point Systems
· Research Areas: Scientific Computing and High-Performance Computing
· Advisor: Luke N. Olson

University of California, San Diego *Jun 2015*
Double Major: Bachelor of Science (B.S.)
· Applied Mathematics & Computational Physics

RESEARCH EXPERIENCE

Scientific Computing Group Dept. of Computer Science, UIUC *Aug 2018 - Present*
Graduate Research Assistantship Urbana, IL

· Led the development of novel multilevel methods, enhancing computational efficiency in the numerical solution of discrete saddle point systems from mixed finite-element discretizations of incompressible fluid flow equations. Greatly reduced iterations to convergence and time-to-solution for solving complex PDE systems.
  - Supervisors: Luke Olson, Scott MacLachlan
  - Research Areas: High-order element discretization, Multi-level methods, Design of Schwarz-type relaxation methods, High-Performance Computing Tensor Algebra

Sandia National Laboratories, Center for Computing Research *Summers 2020-2023*
Graduate Student Intern Livermore, CA

· Conducted research on innovative algebraic multigrid coarsening approaches and inexact relaxation methods for Stokes equations in coupled field problems. Contributed to the development of new techniques in algebraic coarsening algorithms and patch relaxation methods, which have gained popularity due to their robustness and efficient utilization of many-core architectures.
  - Supervisor: Raymond Tuminaro
  - Research Areas: Algebraic Multigrid Methods, Inexact Relaxation Techniques for Coupled Fields

Lawrence Livermore National Laboratory, Computation Division *Jul 2015 - Aug 2023*
Computer Scientist in Application Simulation, and Quality Group Livermore, CA

· Spearheaded the optimization of the particle-in-cell (PIC) plasma code, crucial for LLNL's plasma physics group. Implemented cutting-edge parallelization strategies using Hybrid MPICH and OpenMP frameworks, resulting in significant enhancements in scalability and computational efficiency.
  - Supervisor: Andrea Schmidt
  - Research Areas: Scalability Optimization, Advanced Parallelization Techniques, Preconditioned Krylov Methods
· Contributed to the enhancement of the Livermore Design Optimization (LiDO) code, utilizing the Modular Finite Element Discretization (MFEM) Library. Assisted in integrating CUDA-based matrix-free solvers, which align with the emerging trends in HPC architecture, thereby improving the efficiency of topology optimization processes.
  - Supervisor: Daniel White and Daniel Tortorelli
  - Research Areas: CUDA, Emerging HPC Architectures, Topology Optimization Preconditioned Krylov Methods
· Investigated novel approaches for forming multigrid components in nonlinear time-dependent systems, leading to a reduction in overall setup costs.

- Supervisor: Ulrike Meier Yang
- Research Areas: Algebraic Multigrid Methods, Non-linear PDEs

Skaggs School of Pharmacy and Pharmaceutical Sciences *Jun 2012 - Jun 2014*
Undergraduate Researcher La Jolla, CA

· Co-developed a new molecular dynamics approach to answer whether the shifts in electron density induced by external charges are best replicated by changes in atom-centered charges or by the addition of atom-centered dipoles.

TEACHING EXPERIENCE

University of Illinois at Urbana-Champaign 2018-2024
Graduate Teaching Assistant Urbana, IL

· Assisted faculty in course preparation and content delivery, conducted discussion sections, created homework problems, and led lectures. Supported students in understanding numerical concepts in computing.
Courses Assisted:

- *Numerical Methods for PDEs (CS555)* *Spring 2023 & 2024*
  Techniques for initial and boundary value problems in PDEs.
- *Parallel Numerical Algorithms (CS554)* *Fall 2023*
  Parallel algorithms in numerical linear algebra and differential equations.
- *Numerical Analysis (CS450)* *Fall 2018 & Spring 2019*
  Emphasis on numerical problem formulation and solution strategies.
- *Numerical Methods (CS357)* *Spring & Fall 2021*
  Introductory scientific computing and data analysis.

PEER-REVIEWED PUBLICATIONS

[1] Voronin, A, MacLachlan, S, Olson, LN, Tuminaro, R. Monolithic Algebraic Multigrid Preconditioners for the Stokes Equations. Arxiv (submitted for publication at SISC). https://arxiv.org/abs/2306.06795.

[2] Voronin, A, He, Y, MacLachlan, S, Olson, LN, Tuminaro, R. Low-order preconditioning of the Stokes equations. Numer Linear Algebra Appl. 2021;e2426. https://doi.org/10.1002/nla.2426.

[3] White, D, Voronin, A. "A computational study of symmetry and well-posedness of structural topology optimization." Structural and Multidisciplinary Optimization 59, no. 3 (2019): 759-766.

[4] Li, A, Voronin, A, Fenley, A, Gilson, M. "Evaluation of Representations and Response Models for Polarizable Force Fields." The Journal of Physical Chemistry B 120, no. 33 (2016): 8668-8684.

TECHNICAL REPORTS AND PROCEEDINGS

[1] Voronin, A, Tuminaro, R, Olson, LN, MacLachlan, S. Adaptive Relaxation Methods based on Patch Reuse for Evolving Linear Systems, in Computer Science Research Institute Summer Proceedings 2023, S.K. Seritan and B.W. Reuter, eds., Technical Report SAND2023-13916R, Sandia National Labratories, 2023, pp. 135–146.

[2] Voronin, A, Tuminaro, R, Olson, LN, MacLachlan, S. Monolithic Algebraic Multigrid Preconditioners for Stokes Systems, in Computer Science Research Institute Summer Proceedings 2022, S.K. Seritan and J.D. Smith, eds., Technical Report SAND2022-10280R, Sandia National Laboratories, 2022, pp. 185-–196.

[3] Voronin, A, Tuminaro, R, Olson, LN, MacLachlan, S. Algebraic Multigrid based on Low-order Systems, in Computer Science Research Institute Summer Proceedings 2021, J.D. Smith and E. Galvan, eds., Technical Report SAND2022-0653R, Sandia National Laboratories, 2020, pp. 147–158.

[4] Voronin, A, Tuminaro, R, Olson, LN, MacLachlan, S. AMG for Mixed Finite Element Representations of PDE Systems, in Computer Science Research Institute Summer Proceedings 2020, A.A. Rushdi and M.L. Parks, eds., Technical Report SAND2020-12580R, Sandia National Laboratories, 2020, pp. 127–137.

[5] Karlin, I., Park, Y., de Supinski, B. R. & et al. (including Voronin, A). Preparation and Optimization of a Diverse Workload for a Large-Scale Heterogeneous System in Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (Association for Computing Machinery, Denver, Colorado, 2019).

CONFERENCE TALKS AND INVITED MINISYMPOSIA PRESENTATIONS

[1] Monolithic AMG Preconditioners for Stokes Equations, *21st Copper Mountain Conference On Multigrid Methods (2023).*

[2] Monolithic AMG Preconditioners for Stokes Equations, *SIAM Conference on Computational Science and Engineering (2023).*

[3] Monolithic SA-AMG for Saddle-point Systems, *AMG Summit (2021)*

[4] AMG for Mixed Finite Element Representations of Systems of PDEs, *SIAM Conference on Computational Science and Engineering (2021).*

[5] LFA of Low-Order Preconditioners for the Stokes equations, *20th Copper Mountain Conference On Multigrid Methods (2021).*

[6] Performance Optimization of Bloch-wave Code for the CORAL Systems, *Applications, Simulations and Quality (ASQ) seminar at LLNL Seminar Series (2018).*

AWARDS, GRANTS AND ACHIEVEMENTS

[1] Computer Science Graduate Fellowship Award - UIUC *(Fall 2023 - Spring 2024).*

[2] Graduate College Presentation Award to present at SIAM Conference. on Computational Science and Engineering - UIUC *(2023).*

[3] Travel Award - NSF-CBMS Conference on Parallel Time Integration. *(2022)*

[4] Travel Award - Argonne Training Program on Extreme-Scale Computing (ATPESC) *(2017).*

TECHNICAL SKILLS

Programming Languages:	C, C++, Python, Matlab
Parallel Programming:	MPI, OpenMP, CUDA, OpenCL, Pthread
HPC Technologies & Libraries:	MFEM, *hypre*, PETSc, Firedrake, deal.II, PyTorch
Debugging & Profiling Tools:	TAU, TotalView, GDB, NVIDIA Visual Profiler, Valgrind
Software Development Tools:	Git, Make, CMake, Travis CI, Docker, Spack

SERVICE

SIAM Student Chapter Treasurer (UIUC) *Aug 2019 - Aug 2022*
SIAM Student Chapter Officer (UIUC) *Aug - May 2018*