Shelby Lockhart, PhD

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Education

Aug 2016 – May 2023 | **University of Illinois at Urbana-Champaign**, Urbana-Champaign, IL, USA
Doctor of Philosophy (PhD) in Computer Science
Advisor: Luke N. Olson
Thesis Title: Reducing Communication Bottlenecks in Iterative Solvers
Research Areas: Scientific Computing and High Performance Computing
Cumulative GPA: 3.71/4.00

Aug 2012 – May 2016 | **Wake Forest University**, Winston-Salem, NC, USA
Bachelor of Science (BS) in Mathematics
Double majored in Computer Science
Cumulative GPA: 3.72 / 4.00, Magna Cum Laude

Research Experience

Scientific Computing Group, Dept. of CS, University of Illinois at Urbana-Champaign
Graduate Research Assistant

Jan 2021 - May 2023 | Advisor: Luke N. Olson
Project: PSAAP Grant - Center for Exascale-enabled Scramjet Design
- Designed models for communication on heterogeneous architectures.
- Designed an optimal point-to-point communication strategy for the unstructured-mesh boundary exchanges for use within the *MIRGE-Com* framework.

Aug 2017 - May 2020 | Advisor: Luke N. Olson
Project: ExxonMobil Research Grant
- Performed a performance analysis of Enlarged Krylov methods at scale.
- Developed optimal node-aware communication and implemented within the RAPtor solver framework.

Scientific Computing Group, Computation, CASC, Lawrence Livermore National Laboratory
Predictive Science Academic Alliance Program III Student Intern

May 2021 - Aug 2021 | Advisor: Carol S. Woodward Co-Advisor: David J. Gardner
- Implemented low synchronization orthogonalization methods within the SUNDIALS codebase for use within Anderson Acceleration.
- Analyzed the parallel performance of low synchronization orthogonalization methods outside of and within the context of Anderson Acceleration.

Scientific Computing Group, Computation, CASC, Lawrence Livermore National Laboratory
Computation Scholar Program Graduate Intern

Jun 2020 - Aug 2020 | Advisor: Carol S. Woodward Co-Advisor: David J. Gardner
- Researched low synchronization orthogonalization methods and their potential use within Anderson Acceleration.

Jun 2018 - Aug 2018 | Advisor: Carol S. Woodward Co-Advisor: David J. Gardner
- Implemented an OpenMP 4.5 N_Vector within the SUNDIALS codebase for offloading computation to GPUs.

Computational and Applied Mathematics Group, Oak Ridge National Laboratory
Department of Energy HERE Graduate Intern

Jun 2017 - Aug 2017 | Advisor: Clayton Webster
Project: Study Reduced Order Modeling for Finite Element Methods

Scientific Computing Group, Dept. of CS, University of Illinois at Urbana-Champaign
Independent Study Research

Aug 2016 - May 2017 | Advisor: Michael Heath
Project: Analysis of the Universal Number Format

Dept. of Mathematics, Wake Forest University
Undergraduate Thesis Research

Aug 2015 - May 2016 | Advisor: Jennifer Erway
Project: Limited-Memory Trust-Region Methods for Sparse Relaxation

Cyber and Information Security Research Group, Oak Ridge National Laboratory
Department of Energy SULI Intern

Jun 2015 - Aug 2015 | Advisor: Robert Bridges
Project: STUCCO (Situation and Threat Understanding by Correlating Contextual Observations)

Teaching Experience

Dept. of CS at University of Illinois at Urbana-Champaign, Urbana-Champaign, IL, USA
Graduate Teaching Assistant

Aug 2020 - Dec 2020 | Course: Numerical Analysis, CS 450 Supervising Professor: Luke N. Olson

Jan 2019 - May 2019 | Course: Numerical Methods for Partial Differential Equations, CS 555
Supervising Professor: Paul Fischer

Jan 2017 - May 2017 | Course: Numerical Analysis, CS 450 Supervising Professor: Paul Fischer

Aug 2016 - Dec 2016 | Course: Numerical Methods, CS 357 Supervising Professor: Andreas Kloeckner

Dept. of CS at Wake Forest University, Winston-Salem, NC, USA
Teaching Assistant

Aug 2015 - May 2016 | Course: Computer Organization (using MIPS assembly) Supervising Professor: Pete Santago

Jan 2015 - May 2015 | Course: Introduction to Computer Science (using Python) Supervising Professor: Pete Santago

Awards and Achievements

Apr 2023 | **Sydney Fernbach Fellowship**, *Finalist*
Lawrence Livermore National Laboratory

Mar 2023 | **Selected to attend Rising Stars in Computational and Data Sciences**
Oden Institute, Sandia National Laboratory, Lawrence Livermore National Laboratory

Oct 2022 | **ACM/IEEE CS George Michael Memorial HPC Fellowship**, *Honorable Mention*
ACM, IEEE Computer Society, SC Conference

Aug 2018 | **Outstanding Poster Presentation**, *Summer Student Poster Symposium*
Lawrence Livermore National Laboratory

Aug 2016 | **Saburo Muroga Endowed Fellowship**
University of Illinois at Urbana-Champaign

May 2016 | **John W. Sawyer Prize in Computer Science**
Wake Forest University

Apr 2015 | **Upsilon Pi Epsilon: International Honor Society for the Computing and Information Disciplines**
Wake Forest University

Apr 2014 | **Pi Mu Epsilon: International Honor Society for Mathematics**
Wake Forest University

Publications

2023 | 1. **Lockhart, S.**, Bienz, A., Gropp, W. & Olson, L. Characterizing the Performance of Node-Aware Strategies for Irregular Point-to-Point Communication on Heterogeneous Architectures. *Parallel Computing* (Apr. 2023).

2. **Lockhart, S.**, Bienz, A., Gropp, W. & Olson, L. Performance Analysis and Optimal Node-Aware Communication for Enlarged Conjugate Gradient Methods. *ACM Trans. Parallel Comput.* **10** (Mar. 2023).

2022 | 3. **Lockhart, S.**, Gardner, D. J., Woodward, C. S., Thomas, S. & Olson, L. N. *Performance of Low Synchronization Orthogonalization Methods in Anderson Accelerated Fixed Point Solvers* in *Proceedings of the 2022 SIAM Conference on Parallel Processing for Scientific Computing* (2022), 49–59.

2021 | 4. Bienz, A., Olson, L. N., Gropp, W. D. & **Lockhart, S.** *Modeling Data Movement Performance on Heterogeneous Architectures* in *2021 IEEE High Performance Extreme Computing Conference (HPEC)* (2021), 1–7.

2019 | 5. Karlin, I., Park, Y., de Supinski, B. R. & et al. (including Shelby Lockhart). *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).

2017 | 6. Adhikari, L., DeGuchy, O., Erway, J. B., **Lockhart, S.** & Marcia, R. F. *Limited-memory trust-region methods for sparse relaxation* in *Wavelets and Sparsity XVII* (eds Lu, Y. M., Ville, D. V. D. & Papadakis, M.) **10394** (SPIE, 2017), 95–102.

Presentations

Apr 2023 | **Sydney Fernbach Fellowship Finalist Technical Seminar**, LLNL, Livermore, CA, USA
Communication Reduction Strategies for Scalable Iterative Solvers

Apr 2023 | **Rising Stars in Computational and Data Sciences**, Austin, TX, USA
Reducing Communication Costs in Scalable Iterative Solvers

Feb 2023 | **SIAM Conference on Computational Science and Engineering (CSE23)**, Amsterdam, Netherlands
Anderson Acceleration on Emerging Architectures

Oct 2022 | **Center for Exascale-enabled Scramjet Design PSAAP Annual Review**, Urbana, IL, USA
Data Movement Modeling

Apr 2022 | **17th Copper Mountain Conference on Iterative Methods**, Virtual
Reducing Communication Costs in ECG with Optimal Node-Aware Communication

Apr 2022 | **Center for Exascale-enabled Scramjet Design PSAAP TST Meeting**, Urbana, IL, USA
Data Movement Modeling

Feb 2022 | **SIAM Conference on Parallel Processing for Scientific Computing Conference Proceedings**, Virtual
Performance of Low Synchronization Orthogonalization Methods in Anderson Accelerated Fixed Point Solvers

May 2021	**ASC PI Meeting 2021**, Virtual *Modeling Data Movement on Heterogeneous Architectures*
Feb 2020	**SIAM Conference on Parallel Processing for Scientific Computing Poster Session**, Seattle, WA, USA *Multi-Step Communication in Enlarged Krylov Subspace Solvers*
Apr 2019	**9th JLESC Workshop**, Knoxville, TN, USA *Designing Scalable Solvers for Enlarged Krylov Subspace Methods*
Aug 2018	**LLNL Summer Student Poster Symposium**, Livermore, CA, USA *Increasing the Portability of SUNDIALS with OpenMP 4.5*

Codebase Contributions

RAPtor: parallel algebraic multigrid solver	Contributed the implementation of block vector operations, *enlarged* Krylov methods, and *Split* optimal node-aware communication.
SUNDIALS	Contributed the implementation of an OpenMP 4.5 N_Vector for increased portability of the SUNDIALS software stack, as well as, low synchronization orthgonalization routines for use within Anderson acceleration in the KINSOL package.
BenchPress	Contributed high-volume ping-pong MPI benchmarking tests.

Technical Skills

Programming Languages	C, C++, Python, MATLAB
Code Management	Make, CMake, bash, vim, git, GoogleTest, pytest, Travis CI
Parallel and Distributed Computing	• MPI, CUDA, OpenMP (including OpenMP with device-offloading), mpi4py • Familiarity with PyOpenCL and PyCuda • Extensive experience developing portable software on various large-scale HPC platforms • Extensive experience benchmarking and modeling MPI communication performance on large-scale HPC platforms
Scientific Libraries	SUNDIALS, *hypre*, MFEM, PETSc, XBraid, LAPACK, cuSPARSE, NumPy, SciPy
Operating Systems	macOS, Unix, Linux, Microsoft Windows
Machine Learning	• Working knowledge of PyTorch • Knowledge of distributed deep learning and related parallelization techniques
Documentation	LaTeX, TikZ, Beamer, Keynote, Microsoft Office

Other Relevant Skills

Communication	• Collaborate well with teams of diverse backgrounds and technical expertise • Ability to communicate objectives and importance of technical work to both technical and non-technical audiences
Research and Analysis	• Problem solving, the ability to break down complex problems into manageable tasks • Critical thinking skills, such as the ability to analyze the impact of hardware configurations on software performance and develop software optimization strategies
Project Management	• Ability to manage research projects and coordinate within a remote-working environment • Effective at designing and adhering to project timelines and deliverables

Other Work Experience

Aug 2014 - May 2016 | **Dept. of Mathematics at Wake Forest University**, Winston-Salem, NC, USA
Math Center Tutor
Tutored in 9 undergraduate mathematics courses
Supervising Professor: Jules Connolly

Aug 2012 - Dec 2014 | **Best Choice Center**, Winston-Salem, NC, USA
Middle School Tutor
Tutored in an after-school program for low-income families
Supervisor: Mildred Houser

Service

2023 | **ExaMPI23: Workshop on Extreme Scale MPI Committee Member**,
SC23: The International Conference on High Performance Computing, Networking, Storage and Analysis

2022 - 2023 | **Community Outreach**, Participated in discussion panels at elementary schools in Urbana-Champaign, IL

2019 - 2020 | **SIAM Student Chapter President**, University of Illinois at Urbana-Champaign, IL, USA

2017 - 2018 | **SIAM Student Chapter Officer**, University of Illinois at Urbana-Champaign, IL, USA

Memberships

Society for Industrial and Applied Mathematics (SIAM)
Association for Computing Machinery (ACM)
Institute of Electrical and Electronics Engineers (IEEE)
Women in High Performance Computing (WHPC)
Association for Women in Mathematics (AWM)

Professional References

Luke N. Olson
University of Illinois at Urbana-Champaign
- Email: lukeo@illinois.edu
- Website: https://lukeo.cs.illinois.edu

Carol S. Woodward
Lawrence Livermore National Laboratory
- Email: woodward6@llnl.gov
- Website: https://people.llnl.gov/woodward6

Amanda Bienz
University of New Mexico
- Email: bienz@unm.edu
- Website: https://www.amandabienz.com

William D. Gropp
University of Illinois at Urbana-Champaign
- Email: wgropp@illinois.edu
- Website: https://wgropp.cs.illinois.edu/

Stephen Thomas
Advanced Micro Devices, Inc
- Email: stephethomas@gmail.com
- Website: https://www.linkedin.com/in/steve-thomas-0b23175