

Shelby Lockhart

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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

Current 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 - Current | Advisor: Luke N. Olson

Project: PSAAP Grant - Center for Exascale-enabled Scramjet Design

- Designed models for communication on heterogeneous architectures culminating in a publication.
- Designing optimal point-to-point communication for the unstructured-mesh boundary exchanges on heterogeneous architectures 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 culminating in a publication.

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, culminating in a publication.

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
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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
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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
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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)
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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

Mar 2023	Selected to attend Rising Stars in Computational and Data Sciences
Oct 2022	ACM/IEEE CS George Michael Memorial HPC Fellowship , <i>Honorable Mention</i>
Aug 2018	Lawrence Livermore National Laboratory <i>Awarded Outstanding Poster Presentation, Summer Student Poster Symposium</i>
Aug 2016	University of Illinois at Urbana-Champaign <i>Awarded Saburo Muroga Endowed Fellowship</i>
May 2016	Wake Forest University <i>Awarded John W. Sawyer Prize in Computer Science</i>
Apr 2015	Wake Forest University <i>Inducted into Upsilon Pi Epsilon: International Honor Society for the Computing and Information Disciplines</i>

Publications

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| 2023 | 1. | Lockhart, S. , Bienz, A., Gropp, W. & Olson, L. Performance Analysis and Optimal Node-Aware Communication for Enlarged Conjugate Gradient Methods. <i>ACM Trans. Parallel Comput.</i> 10 (Mar. 2023). |
| 2022 | 2. | Lockhart, S. , Bienz, A., Gropp, W. & Olson, L. <i>Characterizing the Performance of Node-Aware Strategies for Irregular Point-to-Point Communication on Heterogeneous Architectures</i> in (arXiv, 2022), in submission to <i>Parallel Computing</i> . |
| | 3. | Lockhart, S. , Gardner, D. J., Woodward, C. S., Thomas, S. & Olson, L. N. <i>Performance of Low Synchronization Orthogonalization Methods in Anderson Accelerated Fixed Point Solvers</i> in <i>Proceedings of the 2022 SIAM Conference on Parallel Processing for Scientific Computing</i> (2022), 49–59. |
| 2021 | 4. | Bienz, A., Olson, L. N., Gropp, W. D. & Lockhart, S. <i>Modeling Data Movement Performance on Heterogeneous Architectures</i> in <i>2021 IEEE High Performance Extreme Computing Conference (HPEC)</i> (2021), 1–7. |
| 2019 | 5. | Karlin, I., Park, Y., de Supinski, B. R. & et al. (including Shelby Lockhart). <i>Preparation and Optimization of a Diverse Workload for a Large-Scale Heterogeneous System</i> in <i>Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis</i> (Association for Computing Machinery, Denver, Colorado, 2019). |
| 2017 | 6. | Adhikari, L., DeGuchy, O., Erway, J. B., Lockhart, S. & Marcia, R. F. <i>Limited-memory trust-region methods for sparse relaxation in Wavelets and Sparsity XVII</i> (eds Lu, Y. M., Ville, D. V. D. & Papadakis, M.) 10394 (SPIE, 2017), 95–102. |

Presentations

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| Apr 2023 | Rising Stars in Computational and Data Sciences , Austin, TX, USA
<i>Reducing Communication Costs in Scalable Iterative Solvers</i> |
| Feb 2023 | SIAM Conference on Computational Science and Engineering (CSE23) , Amsterdam, Netherlands
<i>Anderson Acceleration on Emerging Architectures</i> |
| Oct 2022 | Center for Exascale-enabled Scramjet Design PSAAP Annual Review , Urbana, IL, USA
<i>Data Movement Modeling</i> |
| Apr 2022 | 17th Copper Mountain Conference on Iterative Methods , Virtual
<i>Reducing Communication Costs in ECG with Optimal Node-Aware Communication</i> |
| Apr 2022 | Center for Exascale-enabled Scramjet Design PSAAP TST Meeting , Urbana, IL, USA
<i>Data Movement Modeling</i> |
| Feb 2022 | SIAM Conference on Parallel Processing for Scientific Computing Conference Proceedings , Virtual
<i>Performance of Low Synchronization Orthogonalization Methods in Anderson Accelerated Fixed Point Solvers</i> |
| May 2021 | ASC PI Meeting 2021 , Virtual
<i>Modeling Data Movement on Heterogeneous Architectures</i> |
| Feb 2020 | SIAM Conference on Parallel Processing for Scientific Computing Poster Session , Seattle, WA, USA
<i>Multi-Step Communication in Enlarged Krylov Subspace Solvers</i> |
| Apr 2019 | 9th JLESC Workshop , Knoxville, TN, USA
<i>Designing Scalable Solvers for Enlarged Krylov Subspace Methods</i> |
| Aug 2018 | LLNL Summer Student Poster Symposium , Livermore, CA, USA
<i>Increasing the Portability of SUNDIALS with OpenMP 4.5</i> |

Codebase Contributions

RAPtor: parallel algebraic multigrid solver	Contributed the implementation of block vector operations, <i>enlarged</i> Krylov methods, and <i>Split</i> 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 orthogonalization routines for use within Anderson acceleration in the KINSOL package.

Relevant Skills

Programming Languages	C, C++, Python, MATLAB
Parallel and Distributed Computing	<ul style="list-style-type: none">• Extensive experience with MPI, CUDA, OpenMP (including OpenMP with device-offloading), and mpi4py• Familiarity with PyOpenCL and PyCuda• Experience with Make and CMake• Extensive experience developing portable software on various large-scale HPC platforms• Extensive experience benchmarking and modeling MPI communication performance on large-scale HPC platforms• Experience with git for project management, as well as GoogleTest for testing

Other Work Experience

Aug 2014 - May 2016	Dept. of Mathematics at Wake Forest University , Winston-Salem, NC, USA <i>Math Center Tutor</i> Tutored in 9 undergraduate mathematics courses Supervising Professor: Jules Connolly
Aug 2012 - Dec 2014	Best Choice Center , Winston-Salem, NC, USA <i>Middle School Tutor</i> Tutored in an after-school program for low-income families Supervisor: Mildred Houser

Service

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

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

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- Website: <https://wgropp.cs.illinois.edu/>