

Amanda Bienz

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Education

University of Illinois at Urbana-Champaign

August 2018

PhD in Computer Science
Scientific Computing and High-Performance Computing
Dissertation: *Reducing Communication in Sparse Solvers*

Elon University

May 2012

B.S. in Computer Science
B.S. in Mathematics

Work Experience

University of New Mexico

Aug 2020 - Present

Assistant Professor

My research is focused on improving the performance and scalability of HPC applications through performance modeling and optimizing data movements. I am also interested in improving data movement through compression and sparsification.

University of Illinois at Urbana-Champaign

Aug 2018 - June 2020

Postdoctoral Researcher - Host: Luke Olson

Researched reducing communication costs in collective operations, improving cost models of graph partitions, and performance models of heterogeneous architectures

INRIA Paris

Apr 2016 - Jul 2016

NSF Grow Participant - Host: Laura Grigori

Explored reducing communication costs in sparse matrix-vector multiplication

Lawrence Livermore National Laboratory

Jun 2014 - Aug 2014

Summer Intern - Host: Jacob Schroder

Research sparse Galerkin methods for algebraic multigrid

University of Illinois at Urbana-Champaign

Aug 2013 - Dec 2013

Graduate Teaching Assistant - Numerical Analysis, CS 450

Led discussion sessions, tutored students, and answered Piazza question board

Lawrence Livermore National Laboratory

May 2013 - Aug 2013

Summer Intern - Host: Jacob Schroder

Explored non-Galerkin methods for algebraic multigrid

Elon University

Feb 2012 - May 2012

Android Software Developer

Created an android tablet application for Biology summer students

Elon University

Aug 2010 - Dec 2012

Computer Science Tutor

Tutored students for entry level computer science courses

NSF REU Summer Intern

May 2011 - Aug 2011

Depauw University, Greencastle, IN

Analyzed methods for parallelizing genetic algorithms in Erlang

Undergraduate Teaching Assistant

Feb 2011 - May 2011

Elon University, Elon, NC

Tutored and advised students in an entry level computer science class

NSF REU Summer Intern

May 2010 - Aug 2010

Clemson University, Clemson, SC

Researched natural language processing for a virtual patient project

Research Projects

Keywords: Parallel Communication, Sparse Matrix Operations, Algebraic Multigrid, Performance Modeling, Inter-Process Communication, MPI, Heterogeneous Architectures

Performance Modeling.....

As supercomputers advance, nodes are increasing in complexity yielding varying costs among messages, dependent on many factors such as the number of processes communicating per node as well as the relative locations of the send and receive processes. Previous work has included investigating performance models for the SpMV on SMP nodes, particularly for situations in which a large number of small messages are communication. Accounting for the differences in intra-socket, inter-socket, and inter-node communication, along with modeling the cost of the queue search operation, yields large improvements to SpMV models. Current state-of-the-art supercomputers consist of heterogeneous nodes, with multiple sockets per node, and GPUs connected to each socket. Current research directions include extending performance models to this more complex architecture, differentiating between intra- and inter-socket communication as well as the architecture of communication endpoints, such as communication between two GPUs versus that between a CPU and a GPU. Furthermore, updated performance models are being extended to graph partitioning, during which the number of edge cuts between partitions, or the inter-process message size, is typically minimized. Performance models can help guide the cost model, allowing for partitions targeted for individual architectures.

Node-Aware Communication.....

Supercomputers consist of a large number of connected nodes, each containing many processes. Inter-process MPI communication costs are dependent on, among other factors, the number of messages, message size, and the relative location of processes, with intra-node communication yielding significantly less cost than inter-node. Node-aware communication is a method of analyzing inter-node communication, rather than inter-process, to minimize the cost of data being injected into the network. This work has shown improvement in sparse matrix operations, as well as the full algebraic multigrid solve, by trading inter-node communication for additional, less costly, intra-node messages. Furthermore, node-aware communication yields improvements to collective communication, such as the allreduce, minimizing the number of inter-node messages for small reduction sizes.

Publications

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| Performance Modeling of MPI for Heterogeneous Systems | In Preparation |
| <i>A. Bienz, S. Lockhart, L. N. Olson, and W. D. Gropp. In Preparation</i> | |
| Reducing Communication in Algebraic Multigrid with Multi-step Node Aware Communication | 2020 |
| <i>A. Bienz, L. N. Olson, and W. D. Gropp. The International Journal of High Performance Computing Applications, 34(5), pp. 547–561.</i> | |
| Node-Aware Improvements to Allreduce | 2019 |
| <i>A. Bienz, L. N. Olson, and W. D. Gropp. Proceedings of 2019 IEEE/ACM Workshop on Exascale MPI (ExaMPI), Denver, CO, November 17, 2019.</i> | |
| Node-Aware Sparse Matrix Vector Multiplication | 2019 |
| <i>A. Bienz, L. N. Olson, and W. D. Gropp. Journal of Parallel and Distributed Computing, vol. 130, pg 166-178.</i> | |
| Improving Performance Models for Irregular Point-to-Point Communication | 2018 |
| <i>A. Bienz, L. N. Olson, and W. D. Gropp. Proceedings of the 25th European MPI Users' Group Meeting, Barcelona, Spain, September 23-26, 2018.</i> | |
| Reducing Parallel Communication in Algebraic Multigrid through Sparsification | 2016 |
| <i>A. Bienz, R. Falgout, W. D. Gropp, L. N. Olson, and J. B. Schroder. Siam Journal on Scientific Computing, vol. 38, no. 5, pg. S332-S357</i> | |
| Magic Polygrams | 2013 |
| <i>A. Bienz, K. A. Yokley, and C. Arangala. Involve: A Journal of Mathematics, vol. 6, no. 2, pg. 169-189.</i> | |
| A Generalized Parallel Genetic Algorithm in Erlang | 2011 |
| <i>A. Bienz, K. Fokle, Z. Keller, E. Zulkoski, and S. Thede. MCURCSM, Granville, OH, September 2011.</i> | |

Presentations

Rising Stars in EECS, Urbana, IL <i>Scalable Sparse Solvers and Graph Algorithms</i>	Oct 2019
Invited Speaker - SPPEXA Final Symposium, Dresden, Germany <i>Node-Aware Communication for Multigrid Methods</i>	Oct 2019
Rising Stars in CSE, Austin, TX <i>Reducing Parallel Communication Costs in Sparse Matrix Operations</i>	Apr 2019
SIAM CSE 2019, Spokane, WA <i>RAPtor: Parallel Algebraic Multigrid with Node-Aware Communication</i>	Feb 2019
19th Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO <i>Multi-Step Node-Aware Communication in Parallel AMG</i>	Feb 2019
Invited Speaker - PETSc User Meeting 2018, London, UK <i>A Parallel Algebraic Multigrid Solver with Reduced Communication Costs</i>	Jun 2018
8th JLESC Workshop, Barcelona, Spain <i>A Node-Aware Approach to Reducing Communication in Sparse Matrix Operations</i>	Mar 2018
15th Copper Mountain Conference on Iterative Methods, Copper Mountain, CO <i>Parallel Algebraic Multigrid with Node-Aware Communication</i>	Mar 2018
Doctoral Showcase at Supercomputing 2017, Denver, CO <i>Reducing Communication Costs in Parallel Algebraic Multigrid</i>	Nov 2017
18th Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO <i>Reducing Communication Costs in Sparse Matrix-Vector Multiplication</i>	Mar 2017
SIAM CSE 2017, Atlanta, GA <i>Reducing Parallel Communication Costs in Algebraic Multigrid</i>	Feb 2017
5th JLESC Workshop, Lyon, France <i>Reducing Communication in Sparse Iterative and Direct Solvers</i>	Jun 2016
SIAM PP, Paris, France <i>Topology-Aware Performance Modeling of Parallel SpMV's</i>	Apr 2016
14th Copper Mountain Conference on Iterative Methods, Copper Mountain, CO <i>Hiding Communication Costs in SpMV's and Algebraic Multigrid</i>	Mar 2016
4th JLESC Workshop, Bonn, Germany <i>Topology-Aware Asynchronous Methods and the Sparse Matrix-Vector Multiply</i>	Nov 2015
3rd JLESC Workshop, Barcelona, Spain <i>Topology-Aware Performance Modeling</i>	Jun 2015
17th Copper Mountain Conference on Multigrid Methods, Copper Mountain, CO <i>Reducing Communication Costs in Parallel Algebraic Multigrid</i>	Mar 2015
ACM Student Research Competition at Supercomputing 2014, New Orleans, LA <i>Reducing Network Contention Associated with Parallel Algebraic Multigrid</i>	Nov 2014
13th Copper Mountain Conference on Iterative Methods, Copper Mountain, CO <i>Scalability of Non-Galerkin Parallel Algebraic Multigrid</i>	Apr 2014
AMS Sectional Presentation, Winston-Salem, NC <i>Magic Polygrams</i>	Nov 2011

Posters

Doctoral Showcase at Supercomputing 2017, Denver, CO <i>Reducing Communication Costs in Parallel Algebraic Multigrid</i>	Nov 2017
Supercomputing 2016, Salt Lake City, UT <i>Reducing Parallel Communication Costs in Algebraic Multigrid</i>	Nov 2016
Supercomputing 2015, Austin, TX <i>Analyzing the Performance of a SpMV for Extreme Scale Computers</i>	Nov 2015
ACM Student Research Competition at Supercomputing 2014, New Orleans, LA <i>Reducing Network Contention Associated with Parallel Algebraic Multigrid</i>	Nov 2014

Software

Node-Aware MPI Library	2018
<i>A lightweight MPI wrapper that performs node-aware communication</i>	
RAPtor: parallel algebraic multigrid solver	2017
<i>A parallel algebraic multigrid solver with node-aware communication</i>	

Awards and Achievements

National Science Foundation Graduate Research Fellow	2012 - 2017
National Science Foundation Grow Awardee	2015
First Place in Student Research Competition, Graduate Division	Supercomputing 2014

Service

JLESC Student Committee	2018
<i>University of Illinois's student representative for the joint laboratory on extreme scale computing.</i>	
CS Graduate Academic Council	2015-2017
<i>Committee for improving the graduate student experience</i>	
CS Graduate Student Ambassador	2013-2017
<i>Helped run visit weekend for prospective graduate students</i>	
CS Graduate Application Review Student Volunteer	2016
<i>Reviewed prospective graduate student applications.</i>	
SIAM Student Chapter President	2014-2015
<i>President of UIUC's student chapter</i>	
SIAM Student Chapter Treasurer	2013-2014
<i>Treasurer of UIUC's student chapter</i>	

Memberships

Association of Computing Machinery
Society for Industrial and Applied Mathematics