Robert Underwood

✉ rr.underwood94@gmail.com • 🖥 robertu94.github.io

⌗ github.com/robertu94

Education

Clemson University   **Clemson, SC**
PhD in Computer Science, GPA 3.92/4.0   *December 2021*
Dissertation: Approachable Error Bounded Lossy Compression
Passed Qualifying Exam: May 2018
Co-Advisers: Dr. Amy Apon, Dr. Jon Calhoun, and Dr. Franck Cappello

Clemson University   **Clemson, SC**
Master of Science in Computer Science, GPA 4.0/4.0   *August 2018*
Concentration: Systems and Implementation

Clemson University, Calhoun Honors College   **Clemson, SC**
Bachelor of Science, Suma Cum Laude in Computer Science, GPA 4.0/4.0   *December 2016*
Honors Thesis: Automation in the Classroom, Adviser: Dr. Jacob Sorber

Peer Reviewed Publications

[1]   Julie Bessac et al. "Exploring Lossy Compressibility through Statistical Correlations of Scientific Datasets". In: *The 7th International Workshop on Data Analysis and Reduction for Big Scientific Data*. Co-Author. IEEE. Nov. 2021.

[2]   Dakota Fulp et al. "ARC: An Automated Approach to Resiliency forLossy Compressed Data via Error Correcting Codes". In: *Proceedings of 30th International ACM Symposium on High-Performance Parallel and Distributed Computing*. Co-Author. ACM. June 2021.

[3]   Robert Underwood et al. "Productive and Performant Generic Lossy Data Compression with LibPressio". In: *The 7th International Workshop on Data Analysis and Reduction for Big Scientific Data*. IEEE. Nov. 2021.

[4]   Jiannan Tian et al. "cuSZ: An Efficient GPU Based Error-Bounded Lossy Compression Framework for Scientific Data". In: *Proceedings of 29th International Conference on Parallel Architectures and Compilation Techniques*. Co-Author. ACM. Atlanta, Georgia (virtual), Oct. 2020.

[5]   Robert Underwood et al. "FRaZ: A Generic High-Fidelity Fixed-Ratio Lossy Compression Framework for Scientific Floating-point Data". In: *proceedings of the 9th international conference on performance engineering*. Presented virtually at IPDPS 2020. IEEE. New Orleans, Louisiana (virtual), May 2020, pp. 1–11.

[6]   Robert Underwood, Jason Anderson, and Amy Apon. "Measuring Network Latency Variation Impacts to High Performance Computing Application Performance". In: *Proceedings of the 9th International Conference on Performance Engineering*. presented at ICPE 2018. ACM/SPEC. Berlin, Germany, Apr. 2018, pp. 1–12.

Peer-Reviewed Academic Poster Presentations

Approachable Error Bounded Lossy Compression	**Virtual**
Supercomputing 2021	*November 2021*
Robert Underwood	
Predicting Optimal E.B.L.C. Configuration for Sampled Data	**Spokanne, WA**
S.I.A.M. Conference on Computer Science and Engineering	*February 2019*
Robert Underwood, Jon Calhoun, and Amy Apon	

Research Experience

Argonne National Laboratory   **Lemont, IL**
Post Doctroal Appointee   *2022-*
- Researched applications and approaches of lossy compression to ensure data integrity.
- Researched data movement and checkpointing systems

Clemson University   **Clemson, SC**
Clemson Data Intensive Computing Environments   *2016-2021*
- Researched and modeled reliability and performance of applications using lossy compression
- Developed techniques to understand the impacts of lossy compression on AI applications
- Designed experiments to analyze performance of high performance computing systems
- Designed models to understand and improve the reliability of computer infrastructure
- Researched trade-offs of compressor agnostic tooling for scientific applications

Argonne National Laboratory   **Lemont, IL**
Under Dr. Franck Cappello   *Summer-Fall 2019*
- Researched the design of optimization based techniques for enforcing user-level error bounds
- Designed and implemented LibPressio – a generic abstraction between compression libraries
- Contributed to the design and implementation of SZ – a lossy compression framework – for CPUs and GPUs

Clemson University   **Clemson, SC**
Clemson PERSIST Lab   *2015-2016*
- Designed and developed an automated grading framework using Python, C, Raspberry Pi, and Docker
- System used modular design, supports process isolation, and multiple test formats

Significant Software

LibPressio
https://github.com/robertu94/libpressio   *2019-present*
- High-performance generic abstraction for compression of dense tensors
- Supports 45+ of plugins for compressors and analysis in collaboration with 6 institutions
- Significant plugins include: LibPressio-Opt (automatic configuration of compression), a parallel compression runtime, and the external metrics framework
- Significant integrations include: Python bindings, HDF5-filters, R bindings, ADIOS2, Spack, Z-checker

SZ
https://szcompressor.org/   *2019-present*

○ One of the leading open and transparent Lossy Compression Frameworks for scientific data
○ the SZ framework is a R&D 500 Award Winner for 2021
○ Contributed an early design of SZ for GPUs and the modular SZ-3
○ Implemented the python bindings for SZ

Teaching and Mentoring Experience

Clemson University   **Clemson, SC**
Mentoring   *Summer 2021*
○ Mentored one female and one male, undergraduate student on projects that led to two ACM student research poster submissions and later journal submission.
○ Provided training on git, python, C++, lossy compression, and scientific experiment design

Clemson University   **Clemson, SC**
CPSC/ECE 3220: Operating Systems   *Fall 2018*
○ Graduate Teacher of Record, produced all lectures and most materials
○ Junior/Senior level course - 50 Students enrolled, Completed (78%), Course GPA (2.42)
○ Course materials `https://robertu94.github.io/cpsc3220-f18/`
○ Anonymous Student Assessment Responses:
  - Response Rate (92.3%), Would Recommend (72.2%)
  - Median Results: Effective Instructor (4/5), Helpful Feedback (4/5), Relative Difficulty (5/5)
  - Selected Student Comments:
    · "Definitely. One of the best professors I've had at Clemson."
    · "Yes. He is very knowledgeable [sic] and works very hard to impart that knowledge to others."
    · "Yes, it is obvious that Mr. Underwood is passionate about operating systems and is extensively knowledgable about computer science in general. This course felt overwhelming at times, but I definitely learned a lot through it."

Relevant Coursework

Clemson University   **Clemson, SC**
EES 883: Resilient Infrastructure Systems   *Spring 2018*
○ Prepared a NSF grant proposal submitted by my adviser to NSF and funded by NSF
○ Constructed and quantified uncertainty in a queuing theory and population based model of Infrastructure systems
○ Designed experiments for statistical model validation

Clemson University   **Clemson, SC**
CPSC 820: Parallel Architecture   *Fall 2016*
○ Researched and presented on the design and implementation of Linux Bridge, OpenVSwitch, DPDK, SRIOV, and MACVLAN
○ Designed and conducted experiment to quantify latency variation in RDMA using InfiniBand layers 1, 2, and 4

Clemson University   **Clemson, SC**
CPSC 840: Design and Analysis of Algorithms   *Spring 2016*

- Analyzed and designed amortized, randomized, and approximation algorithms to solve problems.
- Designed time and space efficient data structures

Work Experience

The Boeing Company   **Charleston, SC**
Information Technology Intern   *Summer 2016, 2017*
- Developed improvements for a web based portal system in HTML, Python, and JavaScript
- Developed the user interface for a materials database using HTML and JavaScript
- Designed, developed, and led development on a resource management tool using C#, HTML, and JavaScript.
- Worked on the Network Automation, Tooling, and Standards Integration Team

Unitrends, Inc   **Columbia, SC**
Software Development Intern   *2014-2016*
- Developed GPU offloading for AES encryption using Nvidia CUDA.
- Designed and developed automated configuration scripts for testing environments using Ansible.
- Designed and developed new cloud infrastructure using LVM, Linux, and Docker
- Designed and developed a Dynamic Alert System in Python
- Worked on the Alerts System in PHP, BASH, C, PERL, SQL
- Worked on the internal Customer Incident Analysis web portal using Django, Postgreql, HTML, CSS, and JavaScript

Extracurricular Activities

Clemson University   **Clemson, SC**
Clemson School of Computing Graduate Student Organization, Secretary   *2017-2021*
- Keep minutes and assist with program and logistics
- Coordinate with other student organizations and School of Computing faculty and staff

Clemson University   **Clemson, SC**
Clemson University Cyber Security Team   *2015-2018*
- Primary developer for the Cyber Security reference material, 2016
- Competed in Collegiate Cyber Defense Competition 2015-2016 and Palmetto Cyber Defense Competition, 2015
- Designed and developed scripts to aid in auditing and administration of contest environments, 2016
- Lead training on Mitigating Exploitable patterns in software design and Observability tools

Clemson University   **Clemson, SC**
Clemson Association for Computing Machinery Vice President   *2014-2016*
- Planned and help found the Clemson Association for Computing Machinery Technology Seminar, Fall 2016
- Prepared and presented 4 seminars per semester on Git, Linux, Vim, Firewalls, Unix tools, and other topics, 2014-2016
- Coordinated with President to set up professional development and social events, 2014-2016

Clemson University   **Clemson, SC**
Clemson Association for Computing Machinery Programming Team   *2013-2016*

- Competed in competitions to design efficient algorithms to solve problems
- Team placed 1st at the Mercer Spring Programming Competition in 2014 and 2015
- Team placed 3rd at Association for Computing Machinery Southeast Regional Competition 2015
- Invited to participate in the National Invitational Programming Competition 2015, 2016
- Primary developer for the Clemson Hackpack algorithms reference
- Student apprentice judge at Mercer Programming Competition February 2016.

Professional Presentations

Systemd Tools   **Clemson, SC**
Overview of useful, but lesser know `systemd` features   *November 2017*
CU Cyber

C++ Templates: Staring into the Abyss   **Clemson, SC**
Advanced talk on C++11-17 templates and uses   *April 2017*
Clemson ACM Technology Seminar, Guest talk

Dockerize all the Things!   **Clemson, SC**
Introduction to container technology and uses   *Feburary 2017*
Clemson ACM Technology Seminar, Guest talk

Exploitable III: Reverse Engineering   **Clemson, SC**
Overview of binary analysis, user and kernel level tracers, and debuggers   *September 2016*
CU Cyber and Clemson ACM Crossover Seminar

Automation in the Classroom   **Clemson, SC**
Motivation and demonstration of classroom automation   *April 2016*
School of Computing Seminar, Spring 2016 Seminar Series

Python: A Parser Tongue Primer   **Clemson, SC**
Introduction to idiomatic Python programming   *April 2016*
Clemson ACM Seminar

Exploitable II: Application Design   **Clemson, SC**
Overview of writing secure software   *March 2016*
CU Cyber and Clemson ACM Crossover Seminar

Provisioning At the Speed of Thought   **Clemson, SC**
Evaluation and Uses of Ansible, Salt and Puppet   *October 2016*
Clemson ACM Technology Seminar

Writing Semantic Code   **Clemson, SC**
Using refactoring and design patterns for better code   *August 2016*
Clemson ACM Technology Seminar

Think Different   **Clemson, SC**
Introduction to approaching computer science projects   *Feburary 2016, et al*
Clemson ACM Various Venues, Also titled "Perfecting Your Projects"

Linux is Scary   **Clemson, SC**
Introduction to Linux for new computer science students   *Feburary 2016, et al*
Clemson ACM Seminar

Thou Shall Not Pass   **Clemson, SC**
Introduction to open source firewalls   *Feburary 2016*
Clemson ACM Seminar

Exploitable: Ethical Hacking   **Clemson, SC**
Introduction to ethical software penetration testing   *October 2015*
CU Cyber and Clemson ACM Crossover Seminar

Git Well Soon   **Clemson, SC**
Introduction to the Git distributed version control system   *September 2015, et al*
Clemson ACM Various Venues, Also titled "Git Thee to a Version Control System"

Intermediate Vim   **Clemson, SC**
Advanced seminar on using the Vim text editor   *Feburary 2015*
Clemson ACM Seminar

N Unix Tools in $O(N)$ Minutes   **Clemson, SC**
Overview of scripting tools for POSIX platforms   *March 2015*
Clemson ACM Seminar

NMAP   **Clemson, SC**
Overview of network mapping with NMAP   *October 2015*
CU Cyber

Computer Skills

Advanced: Bash, Bourne Shell, C, C++, Docker, Linux Kernel and Userspace, Python, Vim

Intermediate: Ansible, Cuda, Git, Hadoop, JAVA, JavaScript, Keras, HDF5, LaTeX, Linux Profiling (perf), LLVM-libtooling, MPI, OpenCL, OpenMP, SQL, SaltStack, SciKit Learn, Spack, Systemd, Tensorflow 2.x

Basic: Apache Spark, ARM assembly, CSS3 C#, Haskell, HTML5, Julia, Perl, Puppet, RCpp/RInside, Rust, SNMP, SVN, FreeBSD, PHP

Professional Affiliations

Association for Computing Machinery: Student Member 2014-2021

Professional Service

Reviewer: ICPE 2017, ICCCN 2017, PABS 2017, SC17, IEEE CLOUD 2018, IEEE TSE 2018, IPDPS 2018, IPDPS 2019, IEEE CLUSTER 2020, Sustainable Computing 2021, IEEE Big Data 2021, PacificVis 2022

Volunteer: SC2018, SCSC21

Honors

- Clemson Outstanding Ph.D. in Computer Science Award, 2021
- Graduate Student Research Lighting Talk Competition Faculty Award, 2020
- Department of Energy Office of Science Graduate Student Research Award, 2019
- Fellowship, National Research Traineeship: Resilient Infrastructure Systems 2017-2020
- National Science Foundation Graduate Research Fellowship Honorable Mention 2017
- Faculty Scholarship Award, Clemson University 2016

- Benefitfocus Scholarship 2015-2016
- McAlister Scholarship 2015-2016
- Palmetto Fellows Recipient 2013-2016
- President's List at Clemson University 2013-2016
- Outstanding Sophomore in Computer Science at Clemson University 2015
- Order of the Arrow, Vigil Honor 2013
- Eagle Scout 2010