Ian Lumsden
Curriculum Vitae

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Research Interests

- High-Performance Computing
- Workflow Scheduling, Orchestration, and Data Movement
- Performance Analysis
- Software Engineering
- Data Analysis

Education

2020–Present	**PhD Computer Science**, *Tickle College of Engineering*, University of Tennessee, Knoxville, TN Concentration in High-Performance Computing
2016–2020	**B.S. Computer Science**, *Tickle College of Engineering*, University of Tennessee, Knoxville, TN Major in Computer Science (Honors Concentration) and Part of Chancellor's Honors Program and Cook Grand Challenge Engineering Honors Program

Professional/Research Experience

Aug 2020–Present	**Graduate Research Assistant**, *Global Computing Laboratory*, University of Tennessee, Knoxville, TN
Advisor	Dr. Michela Taufer
Projects	- Developing a benchmark to study data movement motifs in scientific workflows and assess the performance of data movement tools in these motifs - Developing novel techniques and tools based on Flux to assist in data movement for scientific workflows - Developing novel techniques to identify causes of interesting performance phenomena in High-Performance Computing applications using Hatchet - Examining the performance and implications of in-situ and in-transit data analysis of molecular dynamics simulations through the Analytics4MD project (https://analytics4md.org/)

May 2025–Aug 2025	**Summer Graduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Olga Pearce, Dr. Stephanie Brink, Dr. Tom Scogland
Projects	o Conducted a study in which we performed a phase-aware optimization of the I/O of the iPIC3D plasma physics simulation code, achieving a 4.85x throughput improvement using the Rabbit storage system on LLNL's Tuolumne supercomputer o Developed Kubernetes-based infrastructure for LLNL's reproducible benchmarking tutorial series, which includes LLNL's Thicket, Caliper, and Benchpark tools o Further developed the workflow data movement benchmark started the previous summer o Developed Python bindings for LLNL's Adiak tool
May 2024–Aug 2024	**Summer Graduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Olga Pearce, Dr. Jae-Seung Yeom
Projects	o Developed a benchmark to study data movement motifs in scientific workflows and assess the performance of data movement tools in these motifs o Conducted a performance study of different CPUs and GPUs with different types of memory using the RAJA Performance Suite with other members of the Thicket team o Refactored the topdown analysis service in LLNL's Caliper performance monitoring tool and added support for Intel Sapphire Rapids CPUs o Developed Python bindings for Caliper and used them to develop performance annotations for LLNL's Hatchet and Thicket tools
May 2023–Aug 2023	**Summer Graduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Jae-Seung Yeom, Dr. Hariharan Devarajan
Projects	o Developed an approach to automatically detect all accessible levels of the storage hierarchy and model it as a bipartite graph o Integrated this approach into LLNL's Dynamic and Asynchronous Data Streamliner (DYAD) o Improved the structure and performance of DYAD and the test suite developed during the previous summer

May 2022–Aug 2022	**Summer Graduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Jae-Seung Yeom
Projects	○ Augmented the workflow framework from the Analytics4MD project to make use of LLNL's Dynamic and Asynchronous Data Streamliner (DYAD) ○ Created a test suite for DYAD based on workflows from the Analytics4MD project ○ Examined the performance of DYAD using our test suite and using the performance data collection tool PerfFlow Aspect
May 2021–Aug 2021	**Summer Graduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Olga Pearce, Dr. Stephanie Brink
Projects	○ Developed a data analysis workflow that uses profiles of LLNL's MARBL multi-physics simulation tool to predict what compiler MARBL should be built with to get the best performance for a particular simulation workload
May 2020–Aug 2020	**Summer Undergraduate Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA
Mentors	Dr. Stephanie Brink, Dr. Abhinav Bhatele, Dr. Olga Pearce, Dr. Todd Gamblin
Projects	○ Designed a new graph-based filtering query language for the Hatchet data analysis tool to enable relationship-based analysis of profiling data ○ Implemented the query language and integrated it into Hatchet's data analysis capabilities ○ Used the query language to perform novel analysis of the performance of different MPI calls in HPC benchmark applications ○ Presented the work associated with this internship at the ACM Student Research Competition at the annual Supercomputing (SC) conference, where it won the 1st place award in the Undergraduate category ○ Presented an expanded version of this work at the ACM Student Research Competition Grand Finals
May 2019–May 2020	**Undergraduate Research Assistant**, *Global Computing Laboratory*, University of Tennessee, Knoxville, TN
Advisor	Dr. Michela Taufer
Projects	○ Developed novel techniques to identify causes of interesting performance phenomena in High-Performance Computing applications using Hatchet ○ Examined the performance and implications of in-situ and in-transit data analysis of molecular dynamics simulations through the Analytics4MD project (https://analytics4md.org/)

May 2017–Dec 2018	**HERE Intern**, *Oak Ridge National Laboratory*, Oak Ridge, TN
Mentors	Dr. Jiao Lin and Dr. Garrett Granroth
Projects	○ Developed GUIs using Python and JavaScript for user data analysis (https://github.com/scikit-beam/ipywe) ○ Updated code to support both Python 2.7 and 3 (https://github.com/mcvine) ○ Developed a Python package to convert XML representations of constructive solid geometry into OpenSCAD code for visualization and 3D-printing purposes (https://github.com/mcvine/SCADGen) ○ Parallelized a Monte-Carlo neutron ray-tracing software package with CUDA (https://github.com/mcvine/McVineGPU)
Aug 2015–May 2016	**Math, Science, and Computer Science Thesis Student**, *Oak Ridge High School*, Oak Ridge, TN
Mentor	Dr. Len Gray
Projects	○ Developed a boundary integral method approach to nonlinear fracture mechanics

Honors and Scholarships

Nov 2024	**SC24 ACM Student Research Competition: Graduate Category**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Atlanta, GA
Nov 2024	**ACM Travel Grant**, *to participate in the ACM Student Research Competition at the ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Atlanta, GA
May 2024	**IPDPS PhD Forum**, *IEEE International Parallel & Distributed Processing Symposium*, San Francisco, CA
Nov 2023	**SC23 ACM Student Research Competition: Graduate Category**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Denver, CO
Nov 2023	**ACM Travel Grant**, *to participate in the ACM Student Research Competition at the ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Denver, CO
Oct 2022	**NSF Travel Scholarship**, *to attend the IEEE International Conference on e-Science*, Salt Lake City, UT
Nov 2020	**SC20 ACM Student Research Competition: Undergraduate Category (1st Place)**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Virtual (originally Atlanta, GA)

Aug 2020–May 2024   **Tennessee Fellowship for Graduate Excellence**, *University of Tennessee, Knoxville, TN*

Aug 2016–May 2020   **Member of Chancellor's Honors Program**, *University of Tennessee, Knoxville, TN*

Aug 2016–May 2020   **Member of Cook Grand Challenge Engineering Honors Program**, *University of Tennessee, Knoxville, TN*

Aug 2016–May 2020   **Volunteer Scholarship (Highest Level)**, *University of Tennessee, Knoxville, TN*

Aug 2016–May 2020   **Hope Scholarship**, *University of Tennessee, Knoxville, TN*

Aug 2016–May 2020   **Herbert and Lillian Duggan Engineering Scholarship**, *University of Tennessee, Knoxville, TN*

Aug 2017–May 2020   **Carol and Malcom Bayless Merit Scholarship**, *University of Tennessee, Knoxville, TN*

Aug 2018–May 2020   **Charles Weaver Memorial Scholarship**, *University of Tennessee, Knoxville, TN*

Papers

[1] **I. Lumsden**, H. Devarajan, I. Yildirim, S. Markidis, A. Hu, I. Peng, L. Pennati, D. Yokelson, S. Brink, O. Pearce, T. Scogland, B. R. de Supinski, G. L. Delzanno, A. Kougkas, X. Sun, and M. Taufer, "Optimizing I/O for an Exascale Implicit Kinetic Plasma Simulation using the Rabbit Storage System," in *IEEE International Conference on Cluster Computing Workshops and Posters (CLUSTER WORKSHOPS)*, 2025, to appear.

[2] G. Laboy, **I. Lumsden**, P. Olaya, J. Marquez, K. W. NG, R. Vargas, and M. Taufer, "GEOtiled-SG: A Scalable Framework for High-Resolution Terrain Parameter Computation," in *Proceedings of the IEEE 21st International Conference on e-Science (e-Science)*, 2025, to appear.

[3] D. Yokelson, S. Brink, J. Burmark, M. McKinsey, B. Bogale, **I. Lumsden**, M. Taufer, T. Scogland, and O. Pearce, "Cross-Architecture Performance Analysis Using the RAJA Performance Suite," in *Proceedings of the 54th International Conference on Parallel Processing*, 2025, to appear.

[4] B. Bogale, **I. Lumsden**, D. Sukkari, D. Yokelson, S. Brink, O. Pearce, and M. Taufer, "Surrogate Models for Analyzing Performance Behavior of HPC Applications using the RAJA Performance Suite," in *Proceedings of the 25th International Conference on Computational Science (ICCS)*, 2025. DOI: 10.1007/978-3-031-97635-3_39, Bogale and Lumsden contributed equally to this work.

[5] O. Pearce, J. Burmark, R. Hornung, B. Bogale, **I. Lumsden**, M. McKinsey, D. Yokelson, D. Boehme, S. Brink, M. Taufer, and T. Scogland, "RAJA Performance Suite: Performance Portability Analysis with Caliper and Thicket," in *Proceedings of the SC '24 Workshops of The International Conference on High Performance Computing, Network, Storage, and Analysis*, 2024. DOI: 10.1109/SCW63240.2024.00162.

[6] H. Devarajan, **I. Lumsden**, C. Wang, K. Georgouli, T. Scogland, J. S. Yeom, and M. Taufer, "DYAD: Locality-Aware Data Management for Accelerating Deep Learning Training," in *Proceedings of the IEEE 36th International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD)*, 2024. DOI: 10.1109/SBAC-PAD63648.2024.00010.

[7] **I. Lumsden**, H. Devarajan, J. Marquez, S. Brink, D. Boehme, O. Pearce, J. S. Yeom, and M. Taufer, "Empirical Study of Molecular Dynamics Workflow Data Movement: DYAD vs. Traditional I/O Systems," in *IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, 2024. DOI: 10.1109/IPDPSW63119.2024.00111.

[8] S. Brink, M. McKinsey, D. Boehme, C. Scully-Allison, **I. Lumsden**, D. Hawkins, T. Burgess, V. Lama, J. Lüttgau, K. E. Isaacs, M. Taufer, and O. Pearce, "Thicket: Seeing the performance experiment forest for the individual run trees," in *Proceedings of the 32nd International Symposium on High-Performance Parallel and Distributed Computing (HPDC)*, 2023. DOI: 10.1145/3588195.3592989.

[9] **I. Lumsden**, J. Luettgau, V. Lama, C. Scully-Allison, S. Brink, K. Isaacs, O. Pearce, and M. Taufer, "Enabling call path querying in hatchet to identify performance bottlenecks in scientific applications," in *Proceedings of the 18th IEEE International Conference on eScience (eScience)*, 2022. DOI: 10.1109/eScience55777.2022.00039.

[10] S. Brink, **I. Lumsden**, C. Scully-Allison, K. Williams, O. Pearce, T. Gamblin, M. Taufer, K. Isaacs, and A. Bhatele, "Usability and performance improvements in hatchet," in *IEEE/ACM International Workshop on HPC User Support Tools (HUST) and Workshop on Programming and Performance Visualization Tools (ProTools)*, 2020, pp. 49–58. DOI: 10.1109/HUSTProtools51951.2020.00013.

[11] J. Bilheux, H. Bilheux, J. Lin, **I. Lumsden**, and Y. Zhang, "Neutron imaging analysis using jupyter python notebook," *Journal of Physics Communications*, vol. 3, no. 8, 2019.

[12] J. Lin, F. Islam, G. Sala, **I. Lumsden**, H. Smith, M. Doucet, M. B. Stone, D. L. Abernathy, G. Ehlers, J. F. Ankner, and G. E. Granroth, "Recent developments of mcvine and its applications at sns," *Journal of Physics Communications*, vol. 3, no. 8, 2019.

[13] **I. Lumsden**, L. Gray, and W. Ye, "Grid-based volume integration for elasticity: Traction boundary integral equation," *Engineering Fracture Mechanics*, vol. 176, pp. 74–82, 2017.

Tutorials

[14] O. Pearce, D. Jacobsen, G. Becker, S. Brink, and **I. Lumsden**, "Reproducible Benchmarking for High-Performance Computing Applications," presented at the 21st IEEE International Conference on e-Science (e-Science), 2025.

[15] D. Yokelson, S. Brink, D. Boehme, **I. Lumsden**, M. Taufer, and O. Pearce, "Reproducible Performance Measurement and Analysis for High-Performance Computing Applications," presented at the 34th ACM International Symposium on High-Performance Parallel and Distributed Computing (HPDC), 2025.

[16] **I. Lumsden**, N. Tan, D. Milroy, V. Sochat, and M. Taufer, "Introduction to Flux: Next-Generation Resource Management for Exascale Workflows and Job Scheduling," presented at the Joint Laboratory for Extreme-Scale Computing Workshop (JLESC), 2024.

Posters

[17] **I. Lumsden**, S. Markidis, A. Hu, I. Peng, L. Pennati, D. Yokelson, S. Brink, O. Pearce, T. Scogland, H. Devarajan, B. R. de Supinski, G. L. Delzanno, and M. Taufer, "Performance Optimization of an Exascale Implicit Kinetic Plasma Simulation on El Capitan," presented at the IEEE 20th International Conference on e-Science (e-Science), 2025, to appear.

[18] **I. Lumsden**, S. Markidis, A. Hu, I. Peng, L. Pennati, D. Yokelson, S. Brink, O. Pearce, T. Scogland, H. Devarajan, B. R. de Supinski, G. L. Delzanno, and M. Taufer, "Performance Optimization of an Exascale Implicit Kinetic Plasma Simulation on El Capitan," presented at the 2025 Salishan Conference on High Speed Computing, 2025.

[19] W. J. Ashworth, **I. Lumsden**, J. Garlick, M. Grondona, O. Pearce, S. Brink, D. Yokelson, D. Milroy, T. Patki, T. Scogland, and M. Taufer, "Flux Emulator: First Insights into Optimizing Scheduling for Exascale HPC," presented at the 34th International Symposium on High-Performance Parallel and Distributed Computing (HPDC), 2025.

[20] Z. Malkmus, N. Tan, **I. Lumsden**, K. Assogba, M. M. Rafique, B. Nicolae, and M. Taufer, "On Optimizing Checkpoint Restoration for HPC Applications: Leveraging Merkle Trees and Asynchronous I/O," presented at the 34th International Symposium on High-Performance Parallel and Distributed Computing (HPDC), 2025.

[21] **I. Lumsden**, O. Pearce, J. S. Yeom, T. Scogland, and M. Taufer, "Benchmarking and Modeling of Producer-Consumer Data Movement Performance in Scientific Workflows," presented at the International Conference for High Performance Computing, Networking, Storage and Analysis (SC), 2024.

[22] **I. Lumsden** and M. Taufer, "Empirical Study of Molecular Dynamics Workflow Data Movement: DYAD vs. Traditional I/O Systems," presented at the PhD Forum at 38th IEEE International Parallel & Distributed Processing Symposium, 2024.

[23] **I. Lumsden** and M. Taufer, "Enabling Transparent, High-Throughput Data Movement for Scientific Workflows on HPC Systems," presented at the Joint Laboratory for Extreme-Scale Computing Workshop (JLESC), 2024.

[24] **I. Lumsden** and M. Taufer, "Enabling Transparent, High-Throughput Data Movement for Scientific Workflows on HPC Systems," presented at the International Conference for High Performance Computing, Networking, Storage and Analysis (SC), 2023.

[25] **I. Lumsden**, J. Luettgau, V. Lama, C. Scully-Allison, S. Brink, K. Isaacs, O. Pearce, and M. Taufer, "Identifying Performance Bottlenecks in Scientific Applications with Call Path Querying," presented at the Salishan Conference on High Speed Computing, 2023.

[26] J. S. Yeom, D. H. Ahn, **I. Lumsden**, J. Luettgau, S. Caino-Lores, and M. Taufer, "Ubique: A new model for untangling inter-task data dependence in complex hpc workflows," presented at the 2022 IEEE 18th International Conference on e-Science (e-Science), 2022. DOI: 10.1109/eScience55777.2022.00068.

[27] **I. Lumsden** and M. Taufer, "Enabling Graph-Based Profiling Analysis Using Hatchet," presented at the International Conference for High Performance Computing, Networking, Storage and Analysis (SC), 2020.

Professional Services

Mar 2025–Nov 2025	**Lead Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, St. Louis, MO
Mar 2024–Nov 2024	**Lead Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Atlanta, GA
Nov 2023	**Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Denver, CO

Mar 2022–Nov 2022	**Lead Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Dallas, TX
Feb 2021–Nov 2021	**Lead Student Volunteer (SCALEr)**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, St. Louis, MO
Nov 2020	**Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Virtual (originally Atlanta, GA)
Nov 2019	**Student Volunteer**, *ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)*, Denver, CO
Mar 2019	**Volunteer**, *FIRST Robotics Smokey Mountain Regional Competition*, Knoxville, TN

Skills

Programming Languages	C, C++, Python, Rust, JavaScript, TypeScript, Kotlin, Java
Parallelism Libraries	MPI, OpenMP, RAJA, CUDA, ROCm, PThreads
Data Analysis Tools	Thicket, Hatchet, NumPy, SciPy, Matplotlib, Pandas, Jupyter, ipywidgets, Polars, Apache Arrow, Apache Spark, Scikit-Learn, Keras, Tensorflow
Build Systems and Packaging Tools	CMake, Spack, Autotools, Cargo, Meson
Testing and Continuous Integration Tools	PyTest, GitHub Actions, GoogleTest, Travis CI
Shells	Bash, Bourne, Zsh
Other	Flux, Caliper, UCX, LaTeX, SQL, Graph Databases, LLVM, HTML, CSS

Professional Memberships

IEEE	Student Member since April 2017
ACM	Student Member since August 2019

Languages

English	Native	
French	Good Understanding	*6 years of study in Middle and High School*