

BEFIKIR BOGALE

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Education

University of Tennessee

PhD in Computer Science

Aug 2024 - Present

Knoxville, TN

University of Tennessee

Bachelor of Science in Computer Science (GPA: 3.94)

Aug 2020 - May 2024

Knoxville, TN

Experience

Global Computing Laboratory - University of Tennessee

Aug 2024 – Present

Graduate Research Assistant

Knoxville, TN

- Developing a methodology to analyze performance variations across different compilers and compiler options using the RAJA Performance Suite.
- Utilizing LLNL-hosted supercomputers to conduct research and performance analysis.
- Collaborating with LLNL, participating in weekly meetings, and deliver milestone reports and software tools to enhance performance optimization efforts.

Lawrence Livermore National Laboratory

May 2025 – Aug 2025

Defense and Science Technology Intern

Livermore, CA

- Built a compiler-plugin-based workflow to correlate LLVM optimization decisions with measured runtime performance
- Implemented an LLVM pass to extract optimization remarks in a structured, machine-readable format for downstream analysis
- Created an LLVM pass to generate static call graphs directly from LLVM IR to support program-structure and optimization studies
- Integrated compiler remark data with runtime metrics in Thicket, enabling contextualized analysis of how specific optimizations influence performance

Lawrence Livermore National Laboratory

May 2024 – Aug 2024

Computing Graduate Scholar

Livermore, CA

- Developed a cluster-based methodology to assess performance portability using the RAJA Performance Suite on Intel Xeon and NVIDIA V100 platforms.
- Utilized Intel's top-down pipeline and advanced clustering techniques to categorize computational kernels based on performance characteristics.
- Collected and analyzed profile metrics to identify performance bottlenecks, with a focus on memory-bound kernels, achieving accurate speedup predictions.
- Collaborated with LLNL and the University of Tennessee to implement and validate the methodology across 73 RAJAPerf kernels, confirming its effectiveness in characterizing performance differentials.

Global Computing Laboratory - University of Tennessee

Oct 2022 – May 2024

Undergraduate Research Assistant

Knoxville, TN

- Developed software for several high-performance computing projects with C/C++, Python, etc. to achieve optimal performance optimizations.
- Improved the reproducibility and scalability of high-performance computing applications through the development of containerized images through the Apptainer and Docker platforms.
- Contributed to the ANACIN-X project, which focuses on characterizing non-determinism in MPI applications, showcasing a an understanding of parallel computing and a commitment to addressing complex challenges in scientific computing.
- Led the development of Jupyter notebooks utilized by researchers for tutorials and enhanced project accessibility.
- Collaborated with Los Alamos National Laboratory, Argonne National Laboratory, and Lawrence Livermore National Laboratory on various projects.

Los Alamos National Laboratory

June 2023 – Aug 2023

Parallel Computing Intern

Los Alamos, NM

- Developed proxy applications on the acceleration of X-ray transport simulations on supercomputers by implementing targeted performance optimizations, focusing on on-node efficiency.

- Ensured code portability by leveraging Kokkos , allowing effortless migration across GPU and CPU architectures and facilitating deployment on diverse high-performance computing clusters.
- Implemented and fine-tuned thread team policies to enhance parallel processing capabilities, resulting in a streamlined and scalable simulation framework.
- Successfully integrated vectorization techniques, significantly enhancing computational throughput for X-ray transport simulations.

Research Projects

Explaining Performance Across Compilers and Compiler Options | *Python, Bash, Thicket* **Aug 2024 - Present**

The project aims to develop a performance analysis methodology to explain variations in HPC application performance across different compilers and compiler options.

- Develop a methodology to analyze performance variations across different compilers and compiler options using RAJAProf and tools like Thicket and Hatchet.
- Refine the methodology to be applicable to benchmarks more representative of standalone HPC applications, using open-source benchmarks such as AMG2023, Kripke, Lagos, and Remhos.
- Apply the refined methodology to the multiphysics code MARBL to evaluate its effectiveness in explaining performance differences across compilers and optimization levels.

Thicket | *C/C++, Python, Kokkos*

Jan 2024 - Present

Thicket is an open-source Python toolkit for Exploratory Data Analysis (EDA) of multi-run performance experiments that enables an understanding of optimal performance configuration for large-scale application codes.

- Analyzing caliper profile outputs for the MARBL multiphysics simulation library designed for exascale systems.
- Developing a scoring mechanism for ranking caliper profiles to determine optimal performance configurations.

Checkpointing using GPU-Accelerated Data De-Duplication | *C/C++, Python, Kokkos* **Aug 2023 - May 2024**

Library developed with the Kokkos portability abstraction that is used for deduplicating memory using a variety of methods with varying complexity and performance.

- Implemented a comparison algorithm that reduces the number of computations in the comparison of merkel trees between checkpoints.
- Validated the performance of Kokkos hash tables in the context of merkel tree creation, find, and insertion at varying configurations.

ANACIN-X (NSF 1900888) | *C/C++, Python*

Oct 2022 - May 2024

ANACIN-X advances the reproducibility study of HPC applications through an open source modular framework for automatic measurement, analysis, and visualization of non-determinism and root causes of non-determinism in MPI applications.

- Created containerized images of ANACIN-X for multiple system architectures using Apptainer which are used by scientists as part of a tutorial apparatus in tackling non-determinism.
- Developed Jupyter notebooks that integrate multiple benchmark applications to demonstrate the practicality of ANACIN-X in identifying and visualizing non-determinism in MPI applications.

Development Projects

Checkpointing on Evolutionary Neural Architecture Search | *Python, Jupyter, Slurm*

- Explored storage-efficient checkpointing methods in Evolutionary Neural Architecture Search (ENAS) to address the challenge of data scarcity for post-hoc analysis due to storage constraints.
- Developed and tested two checkpointing methods, Full and Basic, with Basic Checkpointing optimizing storage by capturing only significant model changes while maintaining prediction accuracy.
- Demonstrated the potential of incremental checkpointing to enhance memory efficiency in ENAS workflows, laying the foundation for further research into advanced checkpointing strategies and improving explainability.

F.R.E.D: Friendly Robot to Ease Dementia | *DART, Python, HTML/CSS, JavaScript*

- Collaborated with the NOVI team to develop the FRED mobile application, aimed at improving the lives of individuals with Alzheimer's Disease and Related Dementias (ADRD) and their caregivers.
- Focused on integrating essential features such as task management, personal reminders, and AI-driven social interaction to enhance user engagement and alleviate isolation.
- Leveraged the capabilities of the existing FRED robot to create a user-friendly, cross-platform mobile app tailored to ADRD patients' needs.

Binary Classification of Income Using Census Data | *Python, Jupyter*

- Explored different machine learning algorithms in predicting household income from census data.
- Utilized data preprocessing, visualization, and systematic model selection with hyperparameter tuning to find the optimal algorithm.
- Identified RBF SVM as the optimal algorithm, achieving 84% training accuracy and 82% testing accuracy, highlighting marital status and education as key elements on income prediction.

Trip Planner | *HTML/CSS, Python, Flask*

- Developed an online outdoor trip planning website that allows users to prepare for trips easily.
- Implemented diverse features such as scheduling, mapping, meal planning, and grocery shopping list functionalities, enriching the platform and providing users with a comprehensive suite of tools to enhance their outdoor adventure planning.

Publications

- [1] **Befikir 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 *Computational Science – ICCS 2025: 25th International Conference, Singapore, Singapore, July 7–9, 2025, Proceedings, Part IV*, Singapore, Singapore: Springer-Verlag, 2025, pp. 327–335, ISBN: 978-3-031-97634-6. DOI: 10.1007/978-3-031-97635-3_39. [Online]. Available: https://doi.org/10.1007/978-3-031-97635-3_39.
- [2] Alexander, M., Bhowmick, S., **Bogale, B.**, Diaz, G., Elster, A., Ellsworth, D. A., Hernandez, C. J. B., Jaffe, E., Marquez, J., Melton, A., Pandey, A., Parete-Koon, S., Tan, N., Taufer, M., Vergara, V., Whitnah, L., and Thiruvathukal, G. K., “EduHPC Lightning Talk Summary,” in *Proceedings of the SC ’23 Workshops of The International Conference on High Performance Computing, Network, Storage, and Analysis*, ser. SC-W ’23, Denver, CO, USA: Association for Computing Machinery, 2023, pp. 374–378, ISBN: 9798400707858. DOI: 10.1145/3624062.3625542. [Online]. Available: <https://doi.org/10.1145/3624062.3625542>.
- [3] O. Pearce, J. Burmark, R. Hornung, **Befikir 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 SC24-W: Workshops of the International Conference for High Performance Computing, Networking, Storage and Analysis*, Atlanta, GA, USA: IEEE Computer Society, Nov. 2024.
- [4] N. Tan, K. Assogba, J. Asworth, **Befikir Bogale**, M. M. Rafique, F. Cappello, M. Taufer, and B. Nicolae, “Towards Affordable Reproducibility Using Scalable Capture and Comparison of Intermediate Multi-Run Results,” in *Proceedings of the 25th ACM/IFIP International Middleware Conference (Middleware)*, Hong Kong, China: ACM, Dec. 2024.

Posters

- [5] **Befikir Bogale**, O. Pearce, T. Scogland, and M. Taufer, “Cluster-Based Methodology for Characterizing the Performance of Portable Applications,” presented at the 33rd ACM/IEEE International Conference for High Performance Computing and Communications Conference (SC), IEEE Computer Society, Nov. 2024.
- [6] **Befikir Bogale**, O. Pearce, S. Brink, D. Boehme, I. L. and Jason Burmark, I. Lumsden, T. Scogland, and M. Taufer, “An Approach for Relating Compiler Optimizations with Runtime Performance,” presented at the 34rd ACM/IEEE International Conference for High Performance Computing and Communications Conference (SC), IEEE Computer Society, Nov. 2025.

Talks

Defense and Science Internship Exit Talk

An Approach for Correlating Compiler Optimizations with Runtime Performance

Aug 2025

Livermore, CA

Supercomputing 24 Student Research Competition

Cluster-based Methodology for Characterizing the Performance of Portable Applications

Nov 2024

Atlanta, GA

Computing Scholar Symposium

Cluster-based Methodology for Characterizing the Performance of Portable Applications

Aug 2024

Livermore, CA

Los Alamos National Laboratory Student Symposium

Accelerating X-Ray Transport Simulations

Aug 2023

Los Alamos, NM

Volunteering

Supercomputing Conference

Apr 2025 – Nov 2025

Lead Student Volunteer

Saint Louis, MO

- Lead Student Volunteer at SC25; oversaw logistics and daily operations for conference workshops
- Facilitated student volunteers, ensuring they understood and executed their assigned duties
- Collaborated closely with conference committees to align volunteer tasks with workshop goals and requirements

Supercomputing Conference

Nov 2024 – Nov 2024

Student Volunteer

Atlanta, GA

- Student Volunteer at SC24; supported conference operations and logistics
- Ensured technical sessions ran smoothly by assisting presenters and attendees
- Performed additional on-site tasks as needed to support conference staff

Hack4Impact

Aug 2023 – Dec 2023

Programmer

University of Tennessee

- Reached out to and developed productivity software for local non-profit organizations.
- Developed an inventory and outreach website in HTML, CSS, and NodeJS.
- Improved the productivity of a non-profit to reach out to supporters and manage donation inventory through the digitization of their inventory bookkeeping.

Technical Skills

Languages: C/C++, Python, Bash, HTML/CSS, DART

Developer Tools/Libraries: OpenMP, CUDA/HIP, MPI, Kokkos, RAJA, Apptainer, Docker, Flask, Jupyter, Caliper

Misc: Linux, Slurm, LSF, Flux, Spack, Git, LLVM