

Matthew J. Davis

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Education

- **Georgia Institute of Technology** 2022 - Present
Ph.D Computer Science
Advisors: Dr. Vivek Sarkar, Dr. Vijay Ganesh
 - President's Fellow
 - **Texas A&M University – College Station** 2022
B.S. of Computer Science & Engineering
 - Engineering Honors
 - Summa Cum Laude
 - Undergraduate Research Scholar
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Technical Skills

Languages: Java, C++, Python, Cuda, C, Bash, SQL, JavaScript
Tools & Frameworks: MPI, OpenMP, Thread Sanitizer, LLVM

Experience

- **Helios Solutions** 2022
Software Engineering Intern *Supervisor: Mr. Joel Busa*
 - Developed software and developer infrastructure tools used by customer Intuitive Machines on their lunar landers: IM-1, IM-2, & IM-3.
 - Created graphic user interface tools for customer TTech's switch and cable modeling.
 - **Argonne National Lab** 2021
Research Aide *Supervisor: Dr. Yanfei Guo*
 - Assisted the pmodel's MPICH team by integrating automated concurrency bug detection passes into their CI systems.
 - Adapted symbolic execution tool KLEE to automatically generate values for unit testing of MPI library functions.
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Research

- **PoLLyMer - Improving Program Verification via LLMs** 2024 – Present
Advisor: Dr. Vijay Ganesh *Collaborators: Ignacio Di Leva*
 - Outperformed SOTA program invariant generation tools (traditional & LLM-based) with a more flexible generation structure.
 - Combines LLM generation with source-level static code transformations and a refinement loop using symbolic feedback from a verifier.
 - Pending review for publication
- **Regent - Configuration Generation for NN Verification** 2024 – Present
Advisor: Dr. Vijay Ganesh *Collaborators: Salil Kamath*
 - Creating a reinforcement learning model trained using fuzzed NN instances to generate per-instance hyperparameter configurations for NN verifiers such as AlphaBetaCrown, optimizing solve time.

- OMPCompound - Hybrid OpenMP Data Mapping Violation Detection & Repair** 2022 – Present
 Advisor: Dr. Vivek Sarkar Collaborators: Lechen Yu
 - This project aims to combine existing tools and some new analysis to tackle the problem of OpenMP Device Data Mapping Consistency Violations.
 - Using OMPSanitizer (static detection), OMPMemOpt (static repair), Arbalest (dynamic detection), & a new static analysis pass AIR to:
 - * Reduce the slowdown/overhead of Arbalest’s dynamic analysis
 - * Lower the false positive rate of OMPSanitizer
 - * Use the repair guidance from OMPMemOpt to repair the bugs automatically
- HPCTest - Detecting Heterogeneous Bugs in Scientific Computing Software** 2022 – 2024
 Advisor: Dr. Vivek Sarkar Collaborators: Manish Motwani
 - Combined LLM input generation, static analysis, guided fuzzing, & differential testing to create a fuzzing-based bug detection system which is scalable to large HPC & Scientific Computing systems.
 - Developed tools to guide the fuzzer using feedback based off analysis of runtime values and execution patterns.
 - Pending review for publication
- Extending OpenRace for CUDA Race Detection** 2020 – 2021
 Advisor: Dr. Jeff Huang Collaborators: Brad Swain, Coderrect Inc.
 - Extended static data race detection tool OpenRace to model and detect races in CUDA 8 and before (no cooperative groups) and fixed flaws in the OpenMP Device offload modeling which improved results on the DataRaceBench benchmark.
 - This work was merged into the OpenRace repository.
- Dynatomic OpenMP Race Detector** 2019 – 2020
 Advisor: Dr. Jeff Huang Collaborators: Dylan Theriot, Fatma Elsheimy
 - Developed a hybrid (static & dynamic) program analysis tool. This tool finds data race bugs in OpenMP programs by combining results from the HPCRace static analysis tool & Google Thread Sanitizer reports.
 - Improved the performance on benchmark DataRaceBench, keeping all true positives of HPCRace and disproving all false positives.
 - This work is published at: [Dynatomic: An OpenMP Race Detection Tool Combining Static and Dynamic Analysis](#)
- NEO-UFO** 2019
 Advisor: Dr. Jeff Huang Collaborators: Yahui Sun, Matthew Chen, Andrew Chin, Andreas Tsouloupas
 - Wrote a static analysis pass to identify regions in the Chromium browser base which were unlikely to have Use-After-Free (UAF) bugs. Converted these regions into Thread Sanitizer blacklist files to toggle off the expensive tracing and analysis for dynamic analysis tool UFO, greatly reducing the overhead.

Honors & Awards

- Eagle Scout
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Publications

- 2022 - Davis, Matthew James; Theriot, Dylan (2022). Dynatomic: An OpenMP Race Detection Tool Combining Static and Dynamic Analysis. Bachelor’s Thesis. [Link](#)