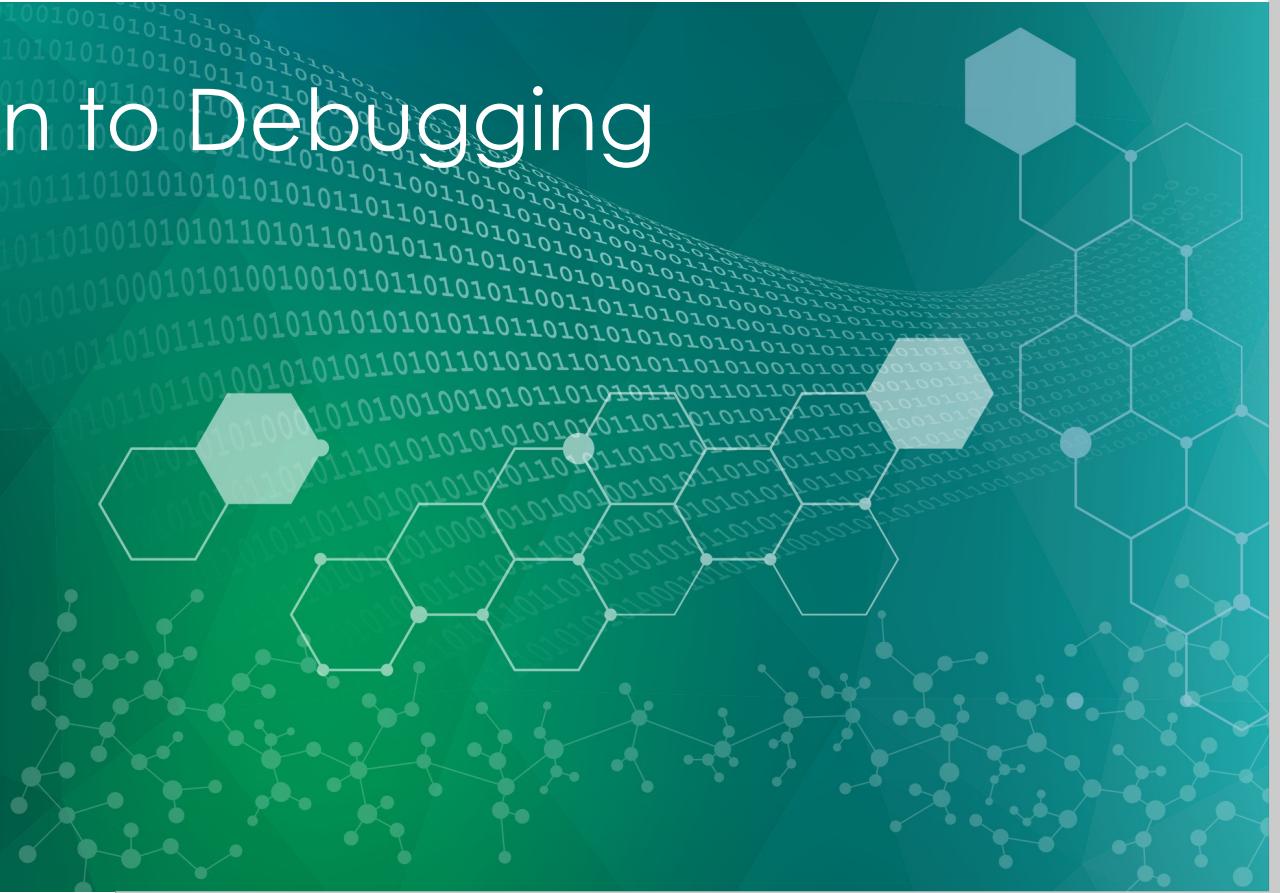


An Interactive Introduction to Debugging

Will Castillo
Elijah MacCarthy
Verónica G. Melesse Vergara

Guest Lecture
Oak Ridge National Laboratory
February 2, 2023

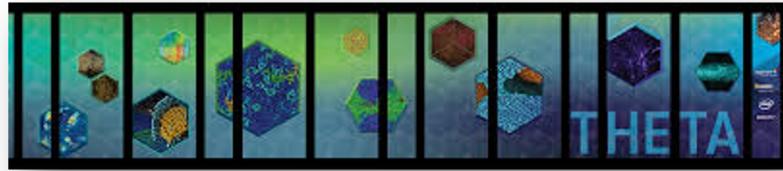
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Outline

- What is the OLCF?
- Why do debuggers exist?
- Classes of debuggers
- Debugging in Action
 - Debugging software on CPUs
 - Debugging software on GPUs
- Summary & References

We are one of the DOE's Office of Science computation user facilities



Argonne Leadership Computing Center



Oak Ridge Leadership Computing Center



- DOE is leader in open high-performance computing
- Provide the world's most powerful computational tools for open science
- Access is free to researchers who publish
- Boost US competitiveness
- Attract the best and brightest researchers

What is a Leadership Computing Facility (LCF)?

- Collaborative, multi-lab DOE initiative (2 centers / 2 architectures)
- Mission: Provide an ecosystem that enables capability computing opportunities to solve the most challenging problems.
- Administer and support two highly competitive user allocation programs
 - Innovative and Novel Computational Impact on Theory and Experiment (INCITE)
 - ASCR Leadership Computing Challenge (ALCC)
 - Computational allocations typically 100x larger than generally available in university, laboratory, and industrial (scientific and engineering) environments.



The OLCF has Successfully Delivered Seven Systems Since 2004

- Frontier is system number seven and provides an increased capability of over 80,000x
- Large part of success has been strong user partnerships to scale & refactor codes/methods
- Partnering has been essential to delivering science in a rapidly changing computational environment



Phoenix X1
• X1e



Jaguar XT3
• Dual core upgrade



Jaguar XT4
• Quad core upgrade



Jaguar XT5
• 6 core upgrade
• 16 core upgrade



Titan XK7
• GPU upgrade



Summit



Frontier

2004

2005

2007

2008

2012

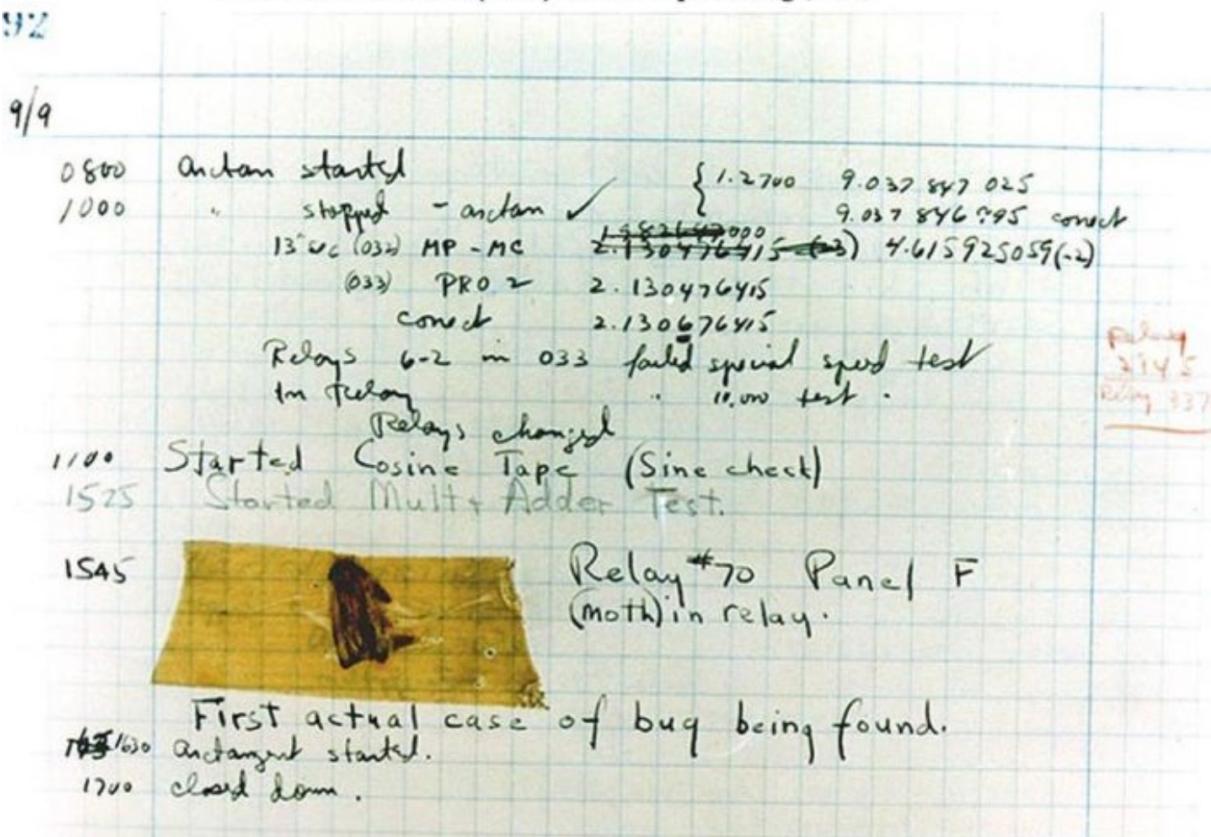
2018

2022

Why do debuggers exist?

- The first bug was found in 1947
 - First recorded case of a bug that disrupted the electronics of a computer
 - Team of programmers which included Dr. Grace Hopper
- Bugs can be highly disruptive to functionality, safety, and security of computer systems

Photo # NH 96566-KN (Color) First Computer "Bug", 1947



<https://education.nationalgeographic.org/resource/worlds-first-computer-bug>

Different Ways to Debug

- In its simplest form:
 - print statements!
- Time consuming, very manual
- Command-line interface (CLI) tools
 - gdb, rocgdb, cuda-gdb
- Graphical user interfaces (GUI)
 - Arm DDT, TotalView



Questions?