DEPARTMENT OF
COMPUTER SCIENCE
TEXAS TECH
Whitacre College of Engineering

From Parallel Computing to Concurrent Data Access: The Dataflow under von Neumann Machine Approach

Xian-He Sun, Ph.D.
Illinois Institute of Technology

Friday, October 3, 2025
4:00 p.m.
TFPETR 110

Abstract: While the success of deep learning hinges on its ability to process vast amounts of data, computing systems struggle to keep up with the unprecedented demand of ever-increasing data, leading researchers back to the notorious memory-wall problem. Unfortunately, the existing paradigms we have, such as parallel computing, multicore, or dataflow, are all designed for speedup computing. They are not designed to address the memory-wall problem. In fact, they have put even more pressure on the already overstressed memory systems. Data access has become the number one performance killer of computing. A paradigm shift is needed for computing from a data-centric point of view. In this talk, we introduce the concept of dataflow under the von Neumann machine paradigm to address this issue. We begin by presenting the C-AMAT model, which quantifies the benefits of concurrent data access and reveals the relationship between data locality and concurrency. Next, we introduce the LPM (Layer Performance Matching) framework to optimize memory system performance and formally introduce the concept of dataflow under the von Neumann machine. We then discuss our recent work in I/O systems, focusing on the Hermes multi-tiered I/O buffering system. Hermes optimizes data movement based on the LPM framework and has been a significant success. Finally, we will address some fundamental issues and present forward-thinking computer system designs for AI and big data applications. We will discuss the critical role of collaborative research infrastructures, like the envisioned StoreHub, in accelerating progress.

Bio: Dr. Xian-He Sun is a University Distinguished Professor, the Ron Hochsprung Endowed Chair of Computer Science, and the director of the Gnosis Research Center for accelerating data-driven discovery at the Illinois Institute of Technology (Illinois Tech). Before joining Illinois Tech, he worked at DoE Ames National Laboratory, at ICASE, NASA Langley Research Center, at Louisiana State University, Baton Rouge, and was an ASEE fellow at Navy Research Laboratories. Dr. Sun is an IEEE fellow and is known for his memory-bounded speedup model, also called Sun-Ni's Law, for scalable computing. His research interests include high-performance data processing, memory and I/O systems, and performance evaluation and optimization. He has over 350 publications and 7 patents in these areas and is currently leading multiple large software development projects in high performance I/O systems. Dr. Sun is the Editor-in-Chief of the IEEE Transactions on Parallel and Distributed Systems, and a former department chair of the Computer Science Department at Illinois Tech. He received the Golden Core award from IEEE CS society in 2017, the ACM Karsten Schwan Best Paper Award from ACM HPDC in 2019, and the first prize best paper award from ACM/IEEE CCGrid in 2021. More information about Dr. Sun can be found on his web site www.cs.iit.edu/~sun/.