Carl D. Laird

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Dr. Laird's research interests include large-scale nonlinear programming, mixed-integer nonlinear programming, and high-performance scientific computing with applications focused on process systems, critical infrastructure protection, and infectious disease spread. Dr. Laird is the recipient of several awards, including the AIChE CAST Division Outstanding Young Researcher Award, the Wilkinson Prize for Numerical Software, and the National Science Foundation Faculty Early Development (CAREER) Award. Dr. Laird earned his Ph.D. in Chemical Engineering from Carnegie Mellon in 2006 and his Bachelor of Science in Chemical Engineering from the University of Alberta.

Algorithms, Architectures, and Applications: High-Performance Mathematical Programming Approaches for Improved Safety and Security

Mathematical programming has proven to be an effective tool for optimization of chemical processes, and as capabilities advance, large-scale optimization is seeing increased impact in many non-traditional areas as well. Drinking water systems remain vulnerable to both intentional and accidental contamination events, and we have partnered with both industry and federal agencies to develop a suite of tools for effective mitigation system design and real-time response. Infectious diseases remain a significant health concern around the world, and we also have been working with epidemiologists to use advanced mathematical programming techniques to improve our understanding of underlying drivers of infectious disease spread. Through solution of inverse problems based on observed case counts, these results help to quantify the importance of school closures on the spread of childhood infectious diseases. I will discuss these two applications in detail, and provide a brief overview of other areas including design of gas detection systems and power grid optimization.

Engineering and scientific needs like those above continue to push the boundaries of existing mathematical programming software, often outstripping the capabilities of a single CPU workstation. Furthermore, computer chip manufacturers are no longer focusing on increasing clock speeds, and the "free" performance improvements that we have historically enjoyed will no longer be available, unless we develop algorithms that are capable of utilizing modern parallel architectures. In this presentation, we will discuss recent work in scalable parallel algorithms for structured nonlinear mathematical programming problems.

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