Self-aware Computing: Combining Learning and Control to Manage Complex, Dynamic Systems

Abstract

Modern computing systems must meet multiple---often conflicting---goals; e.g., high-performance and low energy consumption. The current state-of-practice involves ad hoc, heuristic solutions to such system management problems that offer no formally verifiable behavior and must be rewritten or redesigned wholesale as new computing platforms and constraints evolve. In this talk, I will discuss my research on building self-aware computing systems that address computing system goals and constraints in a fundamental way, starting with rigorous mathematical models and ending with real software and hardware implementations that have formally analyzable behavior and can be re-purposed to address new problems as they emerge.

These self-aware systems are distinguished by awareness of user goals and operating environment; they continuously monitor themselves and adapt their behavior and foundational models to ensure the goals are met despite the challenges of complexity (diverse hardware resources to be managed) and dynamics (unpredictable changes in input workload or resource availability). In this talk, I will describe how to build self-aware systems through a combination of control theoretic and machine learning techniques. I will then show how this combination enables new capabilities, like increasing system robustness, reducing application energy, and meeting latency requirements even with no prior knowledge of the application.

Bio

Henry Hoffmann is an Associate Professor in the Department of Computer Science at the University of Chicago. He was granted early tenure in 2018. At Chicago he leads the Self-aware computing group (or SEEC project) and conducts research on adaptive techniques for power, energy, accuracy, and performance management in computing systems. He received the DOE Early Career Award in 2015. He has spent the last 17 years working on multicore architectures and system software in both academia and industry. He completed a PhD in Electrical Engineering and Computer Science at MIT where his research on self-aware computing was named one of the ten "World Changing Ideas" by Scientific American in December 2011. He received his SM degree in Electrical Engineering and Computer Science from MIT in 2003. As a Masters student he worked on MIT's Raw processor, one of the first multicores. Along with other members of the Raw team, he spent several years at Tilera Corporation, a startup which commercialized the Raw architecture and created one of the first manycores (Tilera was sold for $130M in 2014). His implementation of the BDTI Communications Benchmark (OFDM) on Tilera's 64-core TILE64 processor still has the highest certified performance of any programmable processor. In 1999, he received his BS in Mathematical Sciences with highest honors and highest distinction from UNC Chapel Hill.