Hardware Support for Shared-memory Concurrency: Reconciling Programmability with Performance

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Abstract

With regard to hardware support for shared-memory concurrency, an inherent trade-off between programmability and performance is presumed. For instance, the most intuitive memory consistency model, sequential consistency (SC), is presumed to be too expensive to support; likewise primitive synchronization instructions such as memory fences and atomic read-modify writes (RMWs) are costly in current processors; finally, there are question marks about whether cache coherence protocols will scale with increasing number of cores.

In this talk, I will argue that it is indeed possible to provide hardware support that enhances programmability without sacrificing performance. The key insight is semantics-directed design: hardware design should be guided by precise formal specifications instead of ad-hoc informal ones. I will illustrate this idea by showing how SC can be enforced efficiently using a novel technique to enforce memory ordering dubbed conflict ordering. Second, I will show how RMWs can be implemented efficiently in x86 architectures. Third, I will introduce a scalable approach to cache coherence called consistency-directed coherence. I will conclude by outlining the challenges of verifying such consistency-directed (and conventional!) protocols.

Bio

Vijay Nagarajan is a Reader (Associate Professor) at the University of Edinburgh. His research interests span computer architecture and compilers, with a focus on memory consistency models and cache coherence protocols. Vijay received his PhD from University of California, Riverside and MS from University of Arizona. He is a recipient of Intel Early Career Faculty Award and a best-paper award at PACT.