Holistic System Design for Deterministic Multiprocessor Replay

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Abstract

With the advent of multiprocessor systems, it is now the role of the programmers to explicitly expose parallelism and take advantage of parallel computing resources. However, concurrent programming is inherently complex as programmers have to reason about all possible thread interleavings. A deterministic replay system that records and reproduces the execution of parallel programs can serve as a foundation for building many useful tools (e.g., time-travel debugger, fault tolerance system, etc.) by overcoming the inherent non-determinism in multiprocessor systems. While it is well known how to replay uniprocessor systems, it is much harder to provide deterministic replay of shared memory multithreaded programs on multiprocessors because shared memory accesses add a high-frequency source of non-determinism.

I introduce a new insight to deterministic replay that it is sufficient for many replay uses to guarantee only the same output and the final states between the recorded and replayed executions, and thus it is possible to support replay without logging precise shared-memory dependencies. I call this relaxed but sufficient replay guarantee “external determinism” and leverage this observation to build efficient multiprocessor replay systems. In this talk, I will introduce Respec which supports deterministic replay at low overhead with operating system support. Then, I will discuss the on-going research work aiming to provide deterministic replay and offloaded runtime checks for mobile systems.

Speaker’s Biography

Dongyoon Lee is an Assistant Professor of Computer Science at Virginia Tech. He received the M.S. (2009) and Ph.D. (2013) degrees in Computer Science and Engineering at the University of Michigan, Ann Arbor; and the B.S. (2004) degree in Electrical Engineering from the Seoul National University in Korea. Before joining Virginia Tech, he worked as an academic visitor in the next generation middleware platforms department at the IBM T. J. Watson Research Center. He has been awarded ProQuest Distinguished Dissertation Award in 2013 from the University of Michigan; VMWare 2012 Graduate Fellowship; and the best paper at ASPLOS 2011.