ABSTRACT

This paper presents the tracking approach for deriving detectably recoverable (and thus also durable) implementations of many widely-used concurrent data structures. Info-Structure Based (ISB)-tracking amends descriptor objects used in existing lock-free helping schemes with additional fields that track an operation’s progress towards completion and persists these fields to memory in order to ensure detectable recovery. We have applied ISB-tracking to derive detectably recoverable implementations of a queue, a linked list, a binary search tree, and an exchanger. Experimental results show the feasibility of the technique.

1 MOTIVATION

Byte-addressable non-volatile main memory (NVRAM) combines the performance benefits of conventional main memory with the durability of secondary storage. Systems with NVRAM will be more prevalent in the near future. The availability of durable main memory has increased the interest in the crash-recovery model, in which failed processes may be resurrected after the system crashes. Of particular interest is the design of recoverable concurrent data structures, whose operations can recover from crash-failures. Such data structures are important as they are building blocks for constructing simple, well-structured, sound and error-resistant multiprocessor systems. For example, in many big-data applications, shared in-memory tree-based data indices are created for fast data retrieval and useful data analytics.

When designing recoverable data structures, it is important to be able to tell after recovery whether an operation was executed to completion and if so, what its response was, a property called detectable recovery [1, 2]. In many computer systems (e.g., databases), detectable recovery is supported by precisely logging the progress of computations to non-volatile storage, and replaying the log during recovery. Logging imposes significant overheads in time and space. This cost is even more pronounced for concurrent data structures, where there is an extra cost of synchronizing log accesses.

Tracking in Order to Recover —
Detectable Recovery of Lock-Free Data Structures*

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