Making a Better List-set

EECS 395 “Rust”

Feb. 18, 2016
Linearizability, formally

History $H$ is linearizable if it can be extended to complete history $G$ by

- appending responses to some pending invocations, and/or
- discarding the remaining pending invocations

such that there exists an equivalent legal sequential history $S$ where $\rightarrow_G \subseteq \rightarrow_S$. 


Example

\[ H = \]

\[
\begin{align*}
A & \text{ q.enq(3)} \\
B & \text{ q.enq(4)} \\
B & \text{ q:void} \\
B & \text{ q.deq()} \\
B & \text{ q:4} \\
B & \text{ q.enq(6)} \\
\end{align*}
\]
Example

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B q.enq(4)
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B q:4
B q.enq(6)

\[ G = \]
A q.enq(3)
B q.enq(4)
B q:void
B q.deq()
B q:4
A q:void

\[ S = \]
B q.enq(4)
B q:void
A q.enq(3)
A q:void
B q.deq()
B q:4

S is legal and

G 3
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A & \text{ q.enq(3)} \\
A & \text{ q:void} \\
B & \text{ q.deq()} \\
B & \text{ q:4}
\end{align*} \]

\[ S \text{ is legal and } \sim G \]
Can we do better?

Coarse-grained synchronization:

- Lock the whole object for each operation
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- Easy to reason about :-)
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Coarse-grained synchronization:

- Lock the whole object for each operation
- Easy to reason about :-)  
- But sequential bottleneck :-(

Four strategies

1. Fine-grained synchronization

(-) Can synchronize on different parts of object concurrently

(-) But lots of locking/unlocking overhead

Optimistic synchronization

(-) No need to lock while traversing

(-) But need to validate, and may require expensive retries

Lazy synchronization

(-) Less work needed than optimistic synchronization

(-) But contended operations still need to retry

Lock-free synchronization

(-) No longer at the mercy of the scheduler

(-) But complex, and maybe high overhead
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