school of | Computer Science & Statistics

An Experimental Comparison of Concurrent Data Structures

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Background

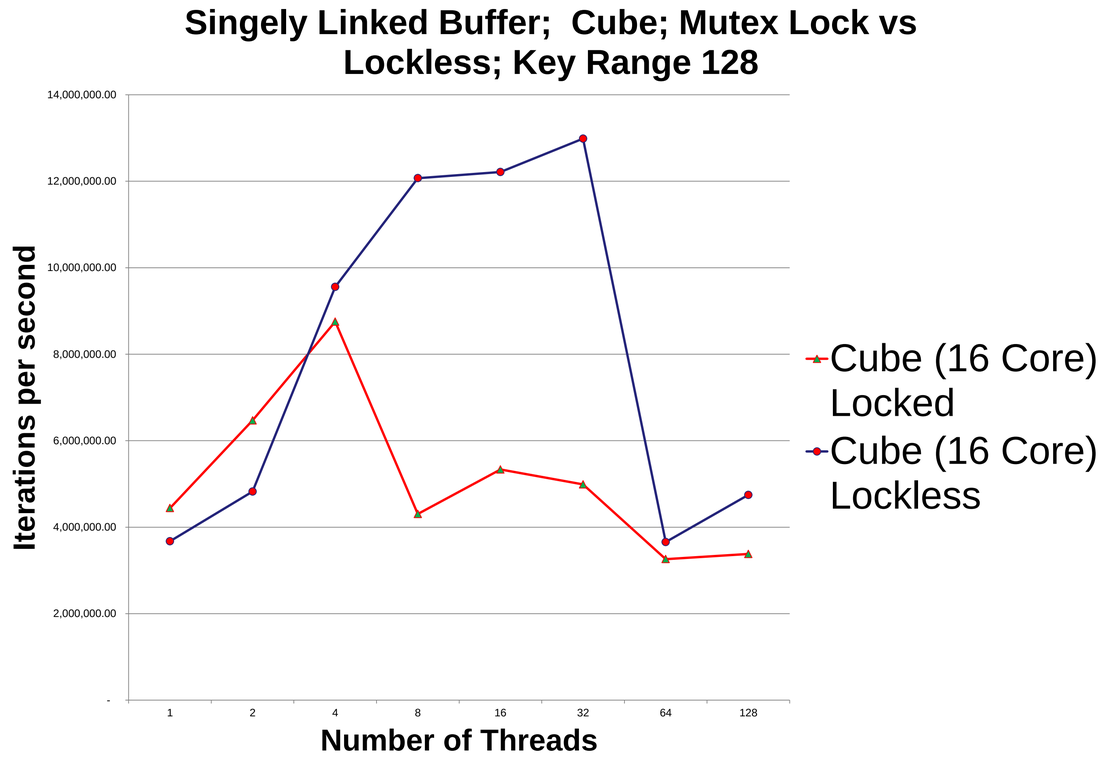
- Concurrent Data Structures
  - Designed for access by multiple threads
  - Potential for high scalability
- Atomic Instructions
  - Either complete fully or not at all
  - Used to implement locked & lockless algorithms
- Locks
  - Use mutexes to acquire/release a lock
  - Blocks threads that don't have the lock
- Lockless
  - Use atomic instructions
  - Guaranteed system throughput
- Not a lot of data comparing locked algorithms versus lockless

Approach

- Implemented three concurrent data structures
  - Ring Buffer
  - Linked List
  - Hash Table
- Each data structure has both locked and lockless variations
- Locked Variations
  - Mutex
  - Test-and-Set
  - Ticket
- Lockless Variations
  - Atomic C++ Library
  - Compare-and-Swap
  - Fetch-and-Add
- Compared each variation on 3 different systems

Evaluation

- Compared Data Structure Variations
  - Varied the thread count from 1-128
  - Modified the sizes of the data structures
  - Main Focus was locked vs lockless
- Used Hardware Performance Counters
  - Special Registers
  - Used for performance analysis
  - Record cache misses, cpu cycles etc
- Ran each data structure variation 7 times and calculated the median to ensure accurate results
- System Details
  - Local Machine (Sandy Bridge 32nm 4 Cores)
  - Stoker (Ivy Bridge 22nm 32 Cores)
  - Cube (Gainestown 45nm 16 Cores)



	Cube 128	Cube Locked
Stalled Front End Cycles	8,603,339,371	28,157,586,014
Stalled Back End Cycles	4,290,118,281	19,235,301,044
CPU Cycles	16,644,060,219	37,007,949,115

Conclusion

- The project was successful in gathering data from a set of concurrent data structures
- Lockless algorithms were generally faster but there were several exceptions
- The linked list showed the largest performance gain when using a lockless algorithm out of the three data structures evaluated
- The hash table's lockless variation was consistently outperformed by the two locked variations tested

BA (Mod) in Computer Science

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