Introduction:
- We present efficient locking mechanisms for hierarchical data structures.
- A hierarchy is characterized by a containment relationship, in which the child nodes are contained within their parent nodes.
- Fine-grained locking: Vs Hierarchical locking.
- Fine-grained locking: Lock at node B only protects node B.

DomLock
- Protocol:
  - A node is allowed to get locked in exclusive mode, if the interval of the node does not overlap with any interval already locked in shared or exclusive mode.
  - A node B: extra node M getting locked.
  - Extra node-M getting locked.
  - It is a trade-off between locking cost and concurrency cost.

NumLock:
- NumLock addresses the issues of DomLock by balancing the locking cost and concurrency cost.
- The locking request is represented as a set of intervals.
- NumLock generates few-pared optimal locking option according to locking cost and concurrency cost.
- Consider locking request H, I, and M.

Cost model for comparing locking options:
- Locking cost: Regression function for the number of intervals locked.
- Contention index: Probability of the lock conflicts because of imprecise locking by a locking option.
- Number of parallel threads.

Hierarchical Locking using Intervals:
- We address the practical issues in Intention Locks (IL) and present a novel approach of Hierarchical locking using intervals.
- We assign an interval value to every node in the hierarchy in a preprocessing phase.
- An interval is a pair (low, high) of integer values assigned to each node.

Properties of Logical Intervals:
- If the Intervals of two nodes subsume, then they have ancestor-descendant relationship.
- If the Intervals of two nodes partially overlap, then they have at least one common descendant node.
- If the Intervals of two nodes are non-overlapping, then the hierarchies rooted at these nodes are disjoint.

Experimental Evaluation:
- Carried out on an Intel Xeon E5-2650 v3 machine.
  - 22 cores at 2.60 GHZ, 128 GB RAM, CentOS 6.5.
  - STMBench: A benchmark to test the effectiveness of locking techniques and the STM implementations.
  - STMBench has two existing locking techniques, Coarse-grained locking and Medium-level locking.
  - Stress Testing:
    - 10 million nodes/leaf trees and directed graph data structures, real-world XML Hierarchy.
    - As we increase the number of lock requests per thread, the locking cost of Intention Locks increases linearly, however, DomLock shows constant locking cost.

Ongoing and Future work:
- The development of a hierarchical locking benchmark which provides a common platform for comparison between different hierarchical and fine-grained locking techniques.
- It allows to choose a certain locking protocol for the execution and provides command-line interface to configure various parameters such as sizes of critical section, the number of nodes in a lock request etc.
- Future work includes the design of a lock manager using concurrent interval trees and evaluate it against the lock managers in the real-world database systems.

References:
  - In PPoPP'16 and a journal version in TOPC'17.
  - In ICPP '18.
  - To be published in EuroPar '18.