Refining Concurrency for Perfomance

Goals: Defining an efficiency-related complexity metric for concurrent data structures.

Tools: Logic, algorithmic reasoning, programming.

Prerequisites: Some maturity in math and algorithms, basic concurrent programming skills.

It is common practice to use the epithet "highly concurrent" referring to data structures that are supposed to perform well in concurrent environments. But how do we measure the concurrency of a data structure in the first place? The notion of a *concurrency-optimal* implementation [5] suggest a way to do it by determining the program's ability to accept *concurrent schedules*, i.e., interleavings of steps of its sequential implementation. A concurrency-optimal program rejects a schedule if and only if the schedule is incorrect, i.e., it results in violating the semantics of the application. Intuitively, such a program program uses synchronization only when it is necessary.

The intuition is however not entirely supported by experiments. While concurrency-optimal data structures compete with state-of-the-art implementations (designed with no notion of optimality in mind), their performance is not consistently superior across different workloads [1, 6].

The goal of this project is to refine the notion of optimality, exploring the space of critical parameters that affect performance of concurrent data structures [2] and taking into account empirical design patterns proposed to improve performance [3, 7]. As a first step, to get an intuition of how this can be done, one may also look at existing search data structures (lists and trees), like the ones already implemented in Synchrobench [4], and try to understand their comparative performance.

Ultimately, this work will contribute to designing a metric that will allow us to build predictably efficient concurrent data structures.

The project is maintained in collaboration with Prof. Vincent Gramoli from the University of Sydney, `http://poseidon.it.usyd.edu.au/~gramoli/web/php/`).

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