

Aspects of dynamic complexity

Thomas Schwentick

TU Dortmund University, Germany
thomas.schwentick@tu-dortmund.de

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In most real-life databases data changes frequently and thus makes efficient query answering challenging. Auxiliary data might help to avoid computing query answers from scratch all the time. One way to study this incremental maintenance scenario is from the perspective of dynamic algorithms with the goal to reduce (re-) computation time. Another option is to investigate it from the perspective of low-level parallel computational complexity [3] or parallelizable database queries [2]. As the “lowest” complexity class AC^0 (with a suitable uniformity condition) and the core of the standard database query language SQL both coincide with first-order predicate logic, one naturally arrives at the question which queries can be answered/maintained dynamically with first-order predicate logic (DYNFO).

The most prominent open question in Dynamic Complexity is whether the reachability query on graphs (arguably the “simplest recursive” query) can be maintained in DYNFO. It has been shown that it can be maintained in DYNFO on undirected [3] or acyclic directed graphs [2] and on directed embedded planar graphs [1], but the general case remains open. Further results in [1] indicate that reachability on graphs might be maintainable in DYNFO, after all.

Despite considerable effort in recent years, showing that a given query can *not* be maintained in DYNFO is a very challenging problem, for which currently no methods are available. Furthermore, even though AC^0 is a small complexity class in the static setting, first-order logic is already quite powerful in the dynamic world. These two observations have recently led to the study of fragments of DYNFO, e.g., by restricting or forbidding quantification, with the idea to start developing inexpressibility tools there. The talk will give an introduction into dynamic complexity, survey some of its most important results, and report about recent work on fragments of DYNFO.

References

- [1] Samir Datta, William Hesse and Raghav Kulkarni, *Dynamic Complexity of Directed Reachability and Other Problems*, ICALP, 2014.
- [2] Guozhu Dong and Jianwen Su, *Incremental and decremental evaluation of transitive closure by first-order queries*, Inf. Comput., 120(1):101–106, 1995.
- [3] Sushant Patnaik and Neil Immerman, *Dyn-FO: A parallel, dynamic complexity class*, J. Comput. Syst. Sci., 55(2):199–209, 1997.