The Dynamic Complexity of the Reachability Problem on Graphs*

Thomas Schwentick

Technische Universität Dortmund

Abstract. Many current data processing scenarios deal with about large collections of permanently changing data. In this context, it is often impossible to compute the answer for a query from scratch. Rather some auxiliary data needs to be stored that helps answering queries quickly, but also requires to be maintained incrementally. This incremental maintenance scenario can be studied in various ways, e.g., from the perspective of dynamic algorithms with the goal to reduce (re-) computation time. Other options are to study the scenario from the perspective of low-level parallel computational complexity [3] or parallelizable database queries [1]. 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 intensily studied query in this dynamic setting is the reachability query on graphs, arguably the "simplest recursive" query. It has been shown that it can be maintained in DynFO on undirected [3] or acyclic directed graphs [1]. However, whether it can be maintained on general directed graphs is considered the main open question of the field.

The talk will give an introduction into dynamic complexity, survey known results on the dynamic complexity of Reachability and report about more recent work on fragments of DynFO and their inability to express Reachability [2,4].

References

1. Dong, G., Su, J.: Incremental and decremental evaluation of transitive closure by first-order queries. Inf. Comput. 120(1), 101–106 (1995)
2. Gelade, W., Marquardt, M., Schwentick, T.: The dynamic complexity of formal languages. ACM Trans. Comput. Log. 13(3), 19 (2012)
3. Patnaik, S., Immerman, N.: Dyn-fo: A parallel, dynamic complexity class. J. Comput. Syst. Sci. 55(2), 199–209 (1997)
4. Zeume, T., Schwentick, T.: On the quantifier-free dynamic complexity of reachability. CoRR, abs/1306.3056 (2013)

* This work was supported by the DFG Grant SCHW678/6-1.

P.A. Abdulla and I. Potapov (Eds.): RP 2013, LNCS 8169, p. 45, 2013.