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Fully Dynamic Shortest Paths and Reachability in Sparse Digraphs

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Abstract: We study the exact fully dynamic shortest paths problem. For real-weighted directed graphs, we show a deterministic fully dynamic data structure with O~(mn^{4/5}) worst-case update time processing arbitrary s,t-distance queries in O~(n^{4/5}) time. This constitutes the first non-trivial update/query tradeoff for this problem in the regime of sparse weighted directed graphs.

Moreover, we give a Monte Carlo randomized fully dynamic reachability data structure processing single-edge updates in O~(n\sqrt{m}) worst-case time and queries in O(\sqrt{m}) time. For sparse digraphs, such a tradeoff has only been previously described with amortized update time~[Roditty and Zwick, SIAM J. Comp. 2008].

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