Dynamic Facility Location via Exponential Clocks

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ABSTRACT

The *dynamic facility location problem* is a generalization of the classic facility location problem proposed by Eisenstat, Mathieu, and Schabanel to model the dynamics of evolving social/infrastructure networks. The generalization lies in that the distance metric between clients and facilities changes over time. This leads to a trade-off between optimizing the classic objective function and the "stability" of the solution: there is a switching cost charged every time a client changes the facility to which it is connected. While the standard linear program (LP) relaxation for the classic problem naturally extends to this problem, traditional LP-rounding techniques do not, as they are often sensitive to small changes in the metric resulting in frequent switches.

We present a new LP-rounding algorithm for facility location problems, which yields the first constant approximation algorithm for the dynamic facility location problem. Our algorithm installs competing exponential clocks on the clients and facilities, and connect every client by the path that repeatedly follows the smallest clock in the neighborhood. The use of exponential clocks gives rise to several properties that distinguish our approach from previous LP-roundings for facility location problems. In particular, we use *no clustering* and we allow clients to connect through paths of *arbitrary lengths*. In fact, the clustering-free nature of our algorithm is crucial for applying our LP-rounding approach to the dynamic problem.

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