Preprocessing Vertex-Deletion Problems: Characterizing Graph Properties by Low-Rank Adjacencies

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October 29, 2019

We consider the Π-FREE DELETION problem parameterized by the size of a vertex cover, for a range of graph properties Π. Given an input graph G, this problem asks whether there is a subset of at most k vertices whose removal ensures the resulting graph does not contain a graph from Π as induced subgraph. When Π is the set of graphs that contain an odd hole or anti-hole, the Π-FREE DELETION problem corresponds to PERFECT DELETION. Many other vertex deletion problems fit into this framework. A kernelization is a preprocessing procedure that given a parameterized instance (x, k), returns an instance (x', k') such that x' and k' are bounded by $f(k)$ for some function f. We introduce the concept of *characterizing a graph property* Π *by low-rank adjacencies*, and use it as the cornerstone of a general kernelization theorem for Π-FREE DELETION parameterized by the size of a vertex cover. The resulting framework captures problems such as AT-FREE DELETION, WHEEL-FREE DELETION, and INTERVAL DELETION. Moreover, our new framework shows that the vertex-deletion problem to perfect graphs has a polynomial kernel when parameterized by vertex cover, thereby resolving an open problem by Fomin et al. [JCSS 2014].