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Algorithmic aspects of upper paired-domination in graphs

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Abstract

A set D of vertices in a graph G is a paired-dominating set of G if every vertex of G is adjacent to a vertex in D and the subgraph induced by D contains a perfect matching (not necessarily as an induced subgraph). A paired-dominating set of G is minimal if no proper subset of it is a paired-dominating set of G. The upper paired-domination number of G, denoted by $\Gamma_{\rm pr}(G)$, is the maximum cardinality of a minimal paired-dominating set of G. In Upper-PDS, it is required to compute a minimal paired-dominating set with cardinality $\Gamma_{\rm pr}(G)$ for a given graph G. In this paper, we show that Upper-PDS cannot be approximated within a factor of $n^{1-\varepsilon}$ for any $\varepsilon > 0$, unless P=NP and Upper-PDS is APX-complete for bipartite graphs of maximum degree 4. On the positive side, we show that Upper-PDS can be approximated within O(Δ)-factor for graphs with maximum degree Δ. We also show that Upper-PDS is solvable in polynomial time for threshold graphs, chain graphs, and proper interval graphs.

Keywords: Domination; Paired-domination; Upper paired-domination; Polynomial time algorithm; NP-complete; APX-complete.

1. Introduction

A set D of vertices of a graph $G = (V, E)$ is a *dominating set* of G if every vertex in $V \setminus D$ is adjacent to some vertex in D. The concept of domination and its variations have many applications and have been widely studied in literature (see [16, 17]); a rough estimate says that it occurs in more than 6000 papers to date. A dominating set of a graph G is *minimal* if no proper subset of it is a dominating set of G. The *domination number* of G, denoted by $\gamma(G)$, is the minimum

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