van Bevern, René

Towards optimal and expressive kernelization for d-hitting set. (English) Zbl 1314.68167

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Summary: A sunflower in a hypergraph is a set of hyperedges pairwise intersecting in exactly the same vertex set. Sunflowers are a useful tool in polynomial-time data reduction for problems formalizable as d-Hitting Set, the problem of covering all hyperedges (whose cardinality is bounded from above by a constant d) of a hypergraph by at most k vertices. Additionally, in fault diagnosis, sunflowers yield concise explanations for "highly defective structures".

We provide a linear-time algorithm that, by finding sunflowers, transforms an instance of d-Hitting Set into an equivalent instance comprising at most $O(k^d)$ hyperedges and vertices. In terms of parameterized complexity, we show a problem kernel with asymptotically optimal size (unless coNP $\subseteq$ NP/poly) and provide experimental results that show the practical applicability of our algorithm.

Finally, we show that the number of vertices can be reduced to $O(k^{d-1})$ with additional processing in $O(k^{1.5d})$ time – nontrivially combining the sunflower technique with problem kernels due to Abu-Khzam and Moser.

MSC:

68Q25 Analysis of algorithms and problem complexity
05C65 Hypergraphs
05C85 Graph algorithms (graph-theoretic aspects)

Keywords:

parameterized algorithmics; linear-time data reduction; vertex cover in hypergraphs; fault diagnosis; sunflower lemma; algorithm engineering

Full Text: DOI

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