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Elementary first-order model checking for sparse graphs

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It is known that for subgraph-closed graph classes the first-order model checking problem is fixed-parameter tractable if and only if the class is nowhere dense [2]. However, the dependency on the formula size is non-elementary, and in fact, this is unavoidable even for the class of all trees [1]. On the other hand, it is known that the dependency is elementary for classes of bounded degree as well as for classes of bounded pathwidth [3]. In this paper we generalise these results and almost completely characterise subgraph-closed graph classes for which the model checking problem is fixed-parameter tractable with an elementary dependency on the formula size. Those are the graph classes for which there exists a number d such that for every r, some tree of depth d and size bounded by an elementary function of r is avoided as an $(\leq r)$-subdivision in all graphs in the class. In particular, this implies that if the class in question excludes a fixed tree as a topological minor, then first-order model checking for graphs in the class is fixed-parameter tractable with an elementary dependency on the formula size.

Références

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[3] Michael Lampis, *First Order Logic on Pathwidth Revisited Again*, Proc. of the 50th International Colloquium on Automata, Languages, and Programming (ICALP 2023), volume 261 of *Leibniz International Proceedings in Informatics (LIPIcs)*, pages 132 :1–132 :17, Dagstuhl, Germany, 2023. Schloss Dagstuhl – Leibniz-Zentrum für Informatik.