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Applying modular decomposition to parameterized cluster editing problems. (English)

Zbl 1179.68111
Theory Comput. Syst. 44, No. 1, 91-104 (2009).

Summary: A graph G is said to be a bicluster graph if G is a disjoint union of bicliques (complete bipartite subgraphs), and a cluster graph if G is a disjoint union of cliques (complete subgraphs). In this work, we study the parameterized versions of the NP-hard Bicluster Graph Editing and Cluster Graph Editing problems. The former consists of obtaining a bicluster graph by making the minimum number of modifications in the edge set of an input bipartite graph. When at most k modifications are allowed (Bicluster(k) Graph Editing problem), this problem is FPT, and can be solved in $O(4^k nm)$ time by a standard search tree algorithm. We develop an algorithm of time complexity $O(4^k + n + m)$, which uses a strategy based on modular decomposition techniques; we slightly generalize the original problem as the input graph is not necessarily bipartite. The algorithm first builds a problem kernel with $O(k^2)$ vertices in $O(n + m)$ time, and then applies a bounded search tree. We also show how this strategy based on modular decomposition leads to a new way of obtaining a problem kernel with $O(k^2)$ vertices for the Cluster(k) Graph Editing problem, in $O(n+m)$ time. This problem consists of obtaining a cluster graph by modifying at most k edges in an input graph. A previous FPT algorithm of time $O(1.92^k+n^3)$ for this problem was presented by *J. Gramm, J. Guo, F. Hüffner* and *R. Niedermeier* [Theory Comput. Syst. 38, No. 4, 373–392, (2005; Zbl 1084.68117); Algorithmica 39, No. 4, 321–347 (2004; Zbl 1090.68027)]. In their solution, a problem kernel with $O(k^2)$ vertices is built in $O(n^3)$ time.

MSC:

68R10 Graph theory (including graph drawing) in computer science
68Q17 Computational difficulty of problems (lower bounds, completeness, difficulty of approximation, etc.)
68Q25 Analysis of algorithms and problem complexity

Cited in **31** Documents

Keywords:

NP-complete problems; fixed-parameter tractability; edge modification problems; cluster graphs; bicluster graphs

Full Text: DOI

References:

[1] Amit, N.: The bicluster graph editing problem. M.Sc. Thesis, Tel Aviv University (2004)

[2] Bauer, H., Möhring, R.H.: A fast algorithm for the decomposition of graphs and posets. Math. Oper. Res. 8, 170–184 (1983) · Zbl 0517.05057 · doi:10.1287/moor.8.2.170

[3] Bretscher, A., Corneil, D., Habib, M., Paul, C.: A simple linear time lexBFS cograph recognition algorithm. In: WG 2003. Lecture Notes in Computer Science, vol. 2880, pp. 119–130 (2003) · Zbl 1255.68108

[4] Cai, L.: Fixed-parameter tractability of graph modification problems for hereditary properties. Inf. Process. Lett. 58, 171–176 (1996) · Zbl 0875.68702 · doi:10.1016/0020-0190(96)00050-6

[5] Coppersmith, D., Winograd, S.: Matrix multiplication via arithmetic progressions. J. Symb. Comput. 9, 251–280 (1990) · Zbl 0702.65046 · doi:10.1016/S0747-7171(08)80013-2

[6] Dahlhaus, E., Gustedt, J., McConnell, R.M.: Efficient and practical algorithms for sequential modular decomposition. J. Algorithms 41, 360–387 (2001) · Zbl 1017.68154 · doi:10.1006/jagm.2001.1185

[7] Dantas da Silva, M., Protti, F., Szwarcfiter, J.L.: Applying modular decomposition to parameterized bicluster editing. In: IWPEC 2006–Second International Workshop on Parameterized and Exact Computation, Zurich, Switzerland. Lecture Notes in Computer Science, vol. 4169, pp. 1–12 (2006) · Zbl 1154.68455

[8] Downey, R.G., Fellows, M.R.: Fixed-parameter tractability and completeness I: basic results. SIAM J. Comput. 24(4), 873–921 (1995) · Zbl 0830.68063 · doi:10.1137/S0097539792228228

[9] Downey, R.G., Fellows, M.R.: Fixed-parameter tractability and completeness II: on completeness for W[1]. Theor. Comput. Sci. 141, 109–131 (1995) · Zbl 0873.68059 · doi:10.1016/0304-3975(94)00097-3

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[10] Downey, R.G., Fellows, M.R.: Parameterized Complexity. Springer, New York (1999)

[11] Fellows, M., Langston, M., Rosamond, F., Shaw, P.: Efficient parameterized preprocessing for cluster editing. Manuscript (2006)

[12] Fernau, H.: Parameterized Algorithms: A Graph-Theoretic Approach. University of Newcastle (2005) · Zbl 1117.68456

[13] Flum, J., Grohe, M.: Parameterized Complexity Theory. Springer, New York (2006)

[14] Gallai, T.: Transitiv orientierbare Graphen. Acta Math. Acad. Sci. Hung. 18, 26–66 (1967) · Zbl 0153.26002 · doi:10.1007/BF02020961

[15] Gramm, J., Guo, J., Hüffner, F., Niedermeier, R.: Graph-modeled data clustering: fixed-parameter algorithms for clique generation. Theory Comput. Syst. 38(4), 373–392 (2005) · Zbl 1084.68117 · doi:10.1007/s00224-004-1178-y

[16] Gramm, J., Guo, J., Hüffner, F., Niedermeier, R.: Automated generation of search tree algorithms for hard graph modification problems. Algorithmica 39(4), 321–347 (2004) · Zbl 1090.68027 · doi:10.1007/s00453-004-1090-5

[17] Guo, J.: A more effective linear kernelization for Cluster Editing. In: Proceedings of the 1st International Symposium on Combinatorics, Algorithms, Probabilistic and Experimental Methodologies (ESCAPE 2007), Hangzhou, China, April 2007. Lecture Notes in Computer Science (2007) · Zbl 1176.05078

[18] Habib, M., Montgolfier, F., Paul, C.: A simple linear-time modular decomposition algorithm for graphs, using order extension. In: 9th Scandinavian Workshop on Algorithm Theory (SWAT 2004). Lecture Notes in Computer Science, vol. 3111, pp. 187–198 (2004) · Zbl 1095.68622

[19] Möhring, R.H., Radermacher, F.J.: Substitution decomposition and connections with combinatorial optimization. Ann. Discret. Math. 19, 257–356 (1984) · Zbl 0567.90073

[20] McConnell, R.M., Spinrad, J.P.: Linear-time modular decomposition and efficient transitive orientation of comparability graphs. In: Proceedings of the Fifth Annual ACM-SIAM Symposium on Discrete Algorithms, vol. 5, pp. 536–545 (1994) · Zbl 0867.05068

[21] McConnell, R.M., Spinrad, J.P.: Ordered vertex partitioning. Discret. Math. Theor. Comput. Sci. 4, 45–60 (2000) · Zbl 0946.68101

[22] Natanzon, A., Shamir, R., Sharan, R.: Complexity classification of some edge modification problems. Discret. Appl. Math. 113, 109–128 (1999) · Zbl 0982.68104 · doi:10.1016/S0166-218X(00)00391-7

[23] Niedermeier, R.: Invitation to Fixed-Parameter Algorithms. Oxford University Press, Oxford (2006) · Zbl 1095.68038

[24] Niedermeier, R., Rossmanith, P.: A general method to speed up fixed-parameter-tractable algorithms. Inf. Process. Lett. 73, 125–129 (2000) · Zbl 1014.68064 · doi:10.1016/S0020-0190(00)00004-1

[25] Shamir, R., Sharan, R., Tsur, D.: Cluster graph modification problems. Discret. Appl. Math. 144, 173–182 (2004) · Zbl 1068.68107 · doi:10.1016/j.dam.2004.01.007

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