

The graph isomorphism problem and the structure of walks

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Abstract

We presents the concept of walk-labeling, that can be used to decide the graph isomorphism problem in polynomial time combinatorially under certain conditions - which hold for a wide range of the graph pairs. It turns out that all non-cospectral graph pairs can be differentiated with a combinatorial method, furthermore, even if the graphs are cospectral and non-isomorphic, they might be distinguished by combinatorially verifying certain properties of their eigenspaces. New polynomial time graph isomorphism algorithms are given under certain spectral conditions and in the case of large graph diameter.

Strong walk-labeling is a refinement of the aforementioned labeling, which has important theoretical and practical applications. Its applications include speeding up backtracking graph matching algorithms, and the generation of graph fingerprints, which uniquely identify all the graphs in the considered databases – including all strongly regular graphs on at most 64 vertices. They are also proved to identify all trees up to isomorphism, and the proof also gives a new isomorphism algorithm for trees. The practical importance of this fingerprint lies in significantly speeding up searching in graph databases, which is a common task in biological and chemical applications. Besides the theoretical results, computational tests have been carried out on biological, random and strongly regular graphs to practically evaluate the efficiency of the proposed methods.

Joint work with Professor Alpár Jüttner.