

Projective-Planar and Toroidal Graphs Avoiding $K_{3,3}$ -Subdivisions: Detection, Forbidden Minors and Enumeration

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Time: Wed. June 23, 12:30, EOW 430

By Kuratowski's theorem, a non-planar graph G contains a subdivision of K_5 or $K_{3,3}$. Suppose that G contains a subdivision of K_5 . We describe a linear-time algorithm which either reduces a projective-planarity-checking or toroidality-checking algorithm to a small constant number of planarity tests, or finds a subdivision of $K_{3,3}$ in G . The algorithm is based on the transformation of a fixed subdivision of K_5 into a subdivision of $K_{3,3}$ in G , or else, on the decomposition of G into smaller pieces. The approach uses the properties of a K_5 -subdivision and its embeddings in the projective plane and torus. It is easy to implement using a breadth-first or depth-first search (joint work with W.L. Kocay).

The algorithmic results show the structure of the corresponding projective-planar and toroidal graphs in terms of planar graphs. The structure can be used to prove Kuratowski type theorems for projective-planar and toroidal graphs with no $K_{3,3}$ -subdivisions (joint work with W. Myrvold).

The uniqueness of the decomposition gives a characterization of projective-planarity for graphs with no $K_{3,3}$ -subdivisions. A refinement of the structural results for the torus provides a characterization of toroidal graphs with no $K_{3,3}$ -subdivisions. The characterizations can be used to enumerate the corresponding projective-planar and toroidal graphs (labelled enumeration, joint work with P. Leroux and G. Labelle).