

Tomaž Pisanski (University of Ljubljana and Colgate University)

Representations of Graphs and Related Combinatorial Structures

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Graph theory is popular and useful, at least in part, because its objects, graphs, can be very easily visualized: we can always draw them in the plane. From the very beginning, drawing problems played an important role in the development of graph theory. The existence of “nice” drawings of certain graphs led to the development of a special theory for planar graphs that culminated in the solution of the four-color problem.

Many researchers, both in mathematics and other fields, now work in the area of graph drawings. For example, chemists have developed methods for “drawing” large molecular graphs in 3-dimensional space in order to find fast approximate solutions to the Schrodinger equation. Geometers have asked seemingly unrelated questions such as: Which combinatorial polyhedra (= maps on surfaces) can be realized as geometric polyhedra? Or: Which combinatorial configurations can be realized as geometric configurations made of points and straight lines? The purpose of this talk is to present evidence that many such problems can be investigated under a single theory that is based on graph representations. Connections between graph representations and nodal domains will be addressed.

This talk is intended for general audience. It is based on a survey chapter I have written with Arjana Žitnik.

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