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Cycle-maximal graphs of fixed girth

Among graphs with n vertices and girth at least g , which ones contain the most subgraphs that are cycles? This question is more difficult than it sounds. Just counting cycles in one graph is already a $\#P$ -complete computational problem closely connected to matrix permanent, and as a theoretical question it connects to difficult open problems in triangle-free graph theory. For $g = 3$ the answer is obvious; for $g = 4$, we conjecture that evenly balanced complete bipartite graphs are cycle-maximal for all n , but only restricted versions of that statement have been proven; and for $g \geq 5$, answers are known by exhaustive search for some small cases but no general pattern has yet emerged. We discuss results on this problem, with an emphasis on the interplay between computational and theoretical work.

Collaboration with Stephane Durocher, David S. Gunderson, and Pak Ching Li.