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The size of topological graphs with restricted crossings

A topological graph is a graph drawn in the plane such that the vertices are distinct points and the edges are Jordan arcs between the vertices. The celebrated crossing lemma gives an upper bound on the number of edges in terms of the number of vertices and the crossing number. We present new upper bounds on the number of edges under certain restrictions on the crossings. Assume G is a topological graph with n vertices such that every edge can be partitioned into two end segments and one middle segment such that (1) each crossing involves one end segment and one middle segment; (2) each middle segment and end segment intersect at most once; and (3) each middle segment crosses at most k end segments that share a vertex. Then G has $O(kn)$ edges. (Joint work with Eyal Ackerman and Radoslav Fulek.)