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Polynomial Planar Directed Grid Theorem

The grid theorem (Robertson, Seymour 1986) is a central results in the study of graph minors. The relation between treewidth and grid minors is particularly tight for planar graphs. The grid theorem for directed graphs was proved in 2015 by Kawarabayashi and Kreutzer but the bounds is very big.

We establish a polynomial bound for the directed grid theorem on planar digraphs. Additionally, we also give “treewidth sparsifier” for directed graphs, which has been already considered in undirected graphs. This result allows us to obtain an Eulerian subgraph of bounded degree in $D$ that still has high directed treewidth.