HARM DERKSEN, University of Michigan
Approximate Categories for the Graph Isomorphism Problem

An isomorphism problem such as the graph isomorphism problem can be formulated as an orbit problem: Given a linear algebraic group G over a field k, a representation V, and two elements $v, w \in V$, do v, w lie in the same G-orbit? For every d we will construct a k-category $C_d(V)$ such that elements in V are objects of $C_d(V)$. If two elements $v, w \in V$ have the same G-orbit, then v and w are isomorphic objects in $C_d(V)$. There exists an efficient algorithm to test whether two objects in $C_d(V)$ are isomorphic. Applied to graphs, this yields a polynomial time algorithm which is often able to distinguish non-isomorphic graphs. The algorithm is at least as good as the higher-dimensional Weisfeiler–Lehman algorithm. Cai, Fürer and Immerman constructed graphs that cannot be distinguished in polynomial time with the Weisfeiler–Lehman method. For $k = \mathbf{F}_2$, our algorithm can distinguish these kind of graphs.