Efficient depth reduction for composites is possible

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Abstract

In 1989 it was shown by Allender and Hertrampf that every circuit of depth \( d \) and gates AND, OR, NOT, and MOD\( p \) can be reduced to a depth 3 circuit of size \( 2^{(\log n)^O(d)} \). The question about MOD\( m \) gates was handled a year later by Yao, and subsequently by Beigel and Tarui, with a triple-exponentially size bound, i.e. \( 2^{((\log n)^2 O(d))} \).

We resolve the question for composites obtaining the same asymptotic result as Allender-Hertrampf.

Depth reduction is a fundamental question on its own. It also has significant implications. For example, one of its immediate consequences is an exponential depth-improvement in Williams’ program for separations of NEXP.

This is joint work with Shiteng Chen.