Some closure results for polynomial factorization

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2/21/2018 at 11:00 am
CoRE 301

Abstract

In a sequence of extremely fundamental results in the 80's, Kaltofen showed that any factor of n-variate polynomial with degree and arithmetic circuit size poly(n) has an arithmetic circuit of size poly(n). In other words, the complexity class VP is closed under taking factors. A very basic question in this context is to understand if other natural classes of multivariate polynomials, for instance, arithmetic formulas, algebraic branching programs, bounded depth arithmetic circuits or the class VNP, are closed under taking factors.

I will talk about the following two results, whose study is motivated by these questions.

1. VNP is closed under taking factors. This confirms a conjecture of B{\"u}rgisser, and improves upon a recent result of Dutta, Saxena and Sinhababu who showed a quasi-polynomial upper bound on the number of auxiliary variables, and the complexity of the verifier circuit of factors of polynomials in VNP.

2. All factors of degree at most (log n)^a of polynomials with poly(n) size depth k circuits have poly(n) size circuits of depth at most O(k + a). This partially answers a question of Shpilka-Yehudayoff and has applications to hardness-randomness tradeoffs for bounded depth arithmetic circuits.

Based on joint work with Chi-Ning Chou and Noam Solomon.