Static Data Structure Lower Bounds Imply Rigidity

Abstract:

We show that static data structure lower bounds in the group (linear) model imply semi-explicit lower bounds on matrix rigidity. In particular, we prove that an explicit lower bound of $t \gg \log^2(n)$ on the cell-probe complexity of linear data structures in the group model, even against arbitrarily small linear space ($s = (1+\epsilon)n$), would already imply a semi-explicit (P$^\text{NP}$) construction of rigid matrices with significantly better parameters than the current state of art (Alon, Panigrahy, and Yekhanin, 2009). Our result further asserts that polynomial ($t > n^\epsilon$) data structure lower bounds against near-maximal space, would imply super-linear circuit lower bounds for log-depth linear circuits (a four-decade open question). In the succinct space regime ($s = n+o(n)$), we show that any improvement on current cell-probe lower bounds in the linear model would also imply new rigidity bounds. Our main result relies on a new connection between the "inner" and "outer" dimensions of a matrix (Paturi and Pudlak, 2006), and on a new worst-to-average case reduction for rigidity, which is of independent interest.

Joint work with Zeev Dvir (Princeton) and Alexander Golovnev (Harvard).