

An Optimal Separation between Two Property Testing Models for Bounded Degree Directed Graphs

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Abstract: We revisit the relation between two fundamental property testing models for bounded-degree $\text{\emph{directed}}$ graphs: the $\text{\emph{bidirectional}}$ model in which the algorithms are allowed to query both the outgoing edges and incoming edges of a vertex, and the $\text{\emph{unidirectional}}$ model in which only queries to the outgoing edges are allowed. Czumaj, Peng and Sohler [STOC 2016] showed that for directed graphs with both maximum indegree and maximum outdegree upper bounded by d , any property that can be tested with query complexity $O_{\varepsilon,d}(1)$ in the bidirectional model can be tested with $n^{1-\Omega_{\varepsilon,d}(1)}$ queries in the unidirectional model. In particular, if the proximity parameter ε approaches 0, then the query complexity of the transformed tester in the unidirectional model approaches n . It was left open if this transformation can be further improved or there exists any property that exhibits such an extreme separation.

We prove that testing $\text{\emph{subgraph-freeness}}$ in which the subgraph contains k source components, requires $\Omega(n^{1-\frac{1}{k}})$ queries in the unidirectional model. This directly gives the first explicit properties that exhibit an $O_{\varepsilon,d}(1)$ vs $\Omega(n^{1-f(\varepsilon,d)})$ separation of the query complexities between the bidirectional model and unidirectional model, where $f(\varepsilon, d)$ is a function that approaches 0 as ε approaches 0. Furthermore, our lower bound also resolves a conjecture by Hellweg and Sohler [ESA 2012] on the query complexity of testing k -star-freeness.

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