Graph Isomorphism in Expected Linear Time and Space

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We present an algorithm to test if two random graphs are isomorphic, and give evidence its time and space complexity are, on average, linear in the number of nodes and edges in the graphs being compared. Our experiments show these results hold even when the graphs are sparse, i.e., in cases where the number of edges in the graph is $O(N)$, where N is the number of nodes in the graph. This is a significant extension of known results where linearity is obtained only when the number of edges is $O(N^2)$. The complexity includes the cost of matching all nodes and edges in the two graphs to exhibit isomorphism, if it exists. We also present evidence that our algorithm exhibits linear performance in some more realistic cases where the randomness is limited – for instance when the graphs are mesh-like or are derived from proteins. We present computational experience on graphs with up to 128,000 nodes and 256,000 edges.