Faster and Simpler Distributed CONGEST-Algorithms for Testing and Correcting Graph Properties

Prof. Dr. Guy Even (Tel Aviv University)

We consider the following problem introduced by [Censor-Hillel et al., DISC 2016]. Design a distributed algorithm that tests whether the network over which the algorithm is running satisfies a given property (e.g., acyclic, bipartite). If the network satisfies the property, then all processors must accept. If the network is ε-far from satisfying the property, then (with probability at least $2/3$) at least one processor must reject. Being ε-far from a property means that at least $\varepsilon \cdot |E|$ edges need to be deleted or inserted to satisfy the property.

Suppose we have an ε-tester that runs in $O(D)$ rounds, where D is the diameter of the network. We show how to transform this tester to an ε-tester that runs in $O((\log n)/\varepsilon))$ rounds. Since cycle-freeness and bipartiteness are easily tested in $O(D)$ rounds, we obtain ε-testers for these properties with a logarithmic number of rounds.

Moreover, for cycle-freeness, we obtain a *corrector* of the graph that locally corrects the graph so that the corrected graph is acyclic. Note that, unlike a tester, a corrector needs to mend the graph in many places in the case that the graph is far from having the property.

We also consider the properties of being C_4-free and free from a specified tree T of size k. We present a distributed ε-tester for C_4-freeness that requires $O(\varepsilon^{-1})$ rounds. We show how to simulate the T-free property tester of [Iwama and Yoshida, 2014] in $O(k^{k^2+1} \cdot \varepsilon^{-k})$ rounds.

Joint work with Reut Levy and Moti Medina.