

Distributed size estimation in anonymous networks

In this talk, we address the problem of estimating the number of agents in anonymous networks, i.e. in networks where nodes cannot disclose their ID or the ID is not guaranteed to be unique. The knowledge of the number of nodes has applications in network maintenance and organization, such as the detection of disconnection of the network into two clusters. A recent result by Cidon and Y. Shavitt [1] and J. M. Hendrickx et al [2] says that no algorithm with bounded bit-complexity returns the exact number of agents in finite time with probability one. Motivated by this negative result, we propose a randomized approach based on the generation of a vector of random numbers paired with consensus algorithms to compute a global quantity from which it is possible to statistically infer the total number of agents. We provide performance quantification in terms of error probability of the proposed estimators for a wide class of random number generators. In particular, we provide a strategy that achieves exponential decay of the error probability as a function of M , i.e. the size of the random vector generated by each agent. This improves upon the current randomized strategies whose error decays as $1/M$. Interestingly, this strategy has links with the Newton-Pepys' problem [3], related to the outcome of dice throws, and with the Euler-Phi function in Number Theory [4].

[1] I. Cidon and Y. Shavitt, "Message terminating algorithms for anonymous rings of unknown size," *Information Processing Letters*, vol. 54, no. 2, pp. 111 – 119, April 1995

[2] . M. Hendrickx, A. Olshevsky, and J. N. Tsitsiklis, "Distributed anonymous discrete function computation and averaging," arXiv:1004.2102v2, (math.OC), Tech. Rep., April 2010

[3] Wikipedia, "Newton Pepys' Problem",
http://en.wikipedia.org/wiki/Newton-Pepys_problem

[4] Wikipedia, "Euler's totient function",
http://en.wikipedia.org/wiki/Euler_totient