David Doty* (doty@ucdavis.edu), One Shields Ave, University of California, Davis, CA 95616.

*Hardness of computing and approximating predicates and functions with leaderless population protocols.*

Population protocols are a distributed computing model appropriate for describing massive numbers of agents with very limited computational power, such as programmable chemical reaction networks in synthetic biology. A population protocol is said to require a leader if every valid initial configuration contains a single agent in a special "leader" state that helps to coordinate the computation. Although the class of predicates and functions computable with probability 1 is the same whether a leader is required or not, it is not known whether a leader is necessary for fast computation.

We show that a wide class of functions and predicates computable by population protocols are not *efficiently* computable, nor are some linear functions even efficiently *approximable*. For example, the widely studied parity, majority, and equality predicates cannot be computed in sublinear time. It requires linear time for a population protocol even to approximate division by a constant or subtraction: for sufficiently small $\gamma > 0$, the output of a sublinear time protocol can stabilize outside the interval $f(m) (1 \pm \gamma)$. We show that it requires linear time to exactly compute many semi-linear functions (e.g., $f(m)=m$ if $m$ is even and $2m$ if $m$ is odd) and predicates (e.g., parity, equality). (Received September 26, 2017)