Oscillatory Population Protocols

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Understanding how autonomy emerges in biological systems and applying it in giving artificial distributed systems autonomous properties motivate our study. Precisely, we focus on self-oscillations that play crucial roles in autonomous biological reactions, and investigate them as a phenomenon in distributed computing. Self-oscillations are often understood as a chemical oscillator provided, for example, by the Belousov–Zhabotinsky reaction. In biological systems, the oscillatory behavior is used as a natural clock to transmit signals and hence transfer information. In artificial distributed systems, self-oscillations could be used to distributely and autonomously implement a clock. This problem emerges in the project of designing molecular robots [2].

In our investigation, we use the population protocol (PP) model introduced by Angluin et al. [1]. PP is used as a theoretical model of a collection of finite-state mobile agents that interact with each other in order to solve a given problem in a cooperative fashion. Computations are done through pairwise interactions and the interaction pattern is unpredictable. PPs can represent not only artificial distributed systems as sensor networks and mobile agent systems, but also natural distributed systems such as chemical reactions and biological systems. We aim in our work at designing algorithms that make a given population exhibits an oscillatory behavior by itself whatever its initial state.

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