Engineered Microbial Communication for Population-Level Behaviour

Angel Goñi Moreno[1] and Martyn Amos[2]

[1]Natural Computing Group, Faculty of Computer Engineering, Universidad Politécnica de Madrid, Spain.
[2]Department of Computing and Mathematics, Manchester Metropolitan University, United Kingdom.
agmoreno@gcn.upm.es

Extended Abstract

Quorum-sensing (QS) has been extensively studied in the context of synthetic biology (Basu *et al*., 2005; Danino *et al.*, 2010; Garcia-Ojalvo *et al*., 2004). It enables a community-level response to emerge once a certain signal *concentration threshold* has been reached. We use QS to design a *multi-strain*, engineered bacterial community with autonomous behaviour. We model our system on the familiar "client-server" architecture, with a single central server and two clients (one "red" and the other "green"). The task we define is that of *oscillation* (Tigges *et al.,* 2009); by engineering feedback between three different strains, we obtain indefinite switching between "red" and "green" outputs. The system is not restricted to simple oscillation, as server cells may be introduced with much more complex behaviours.

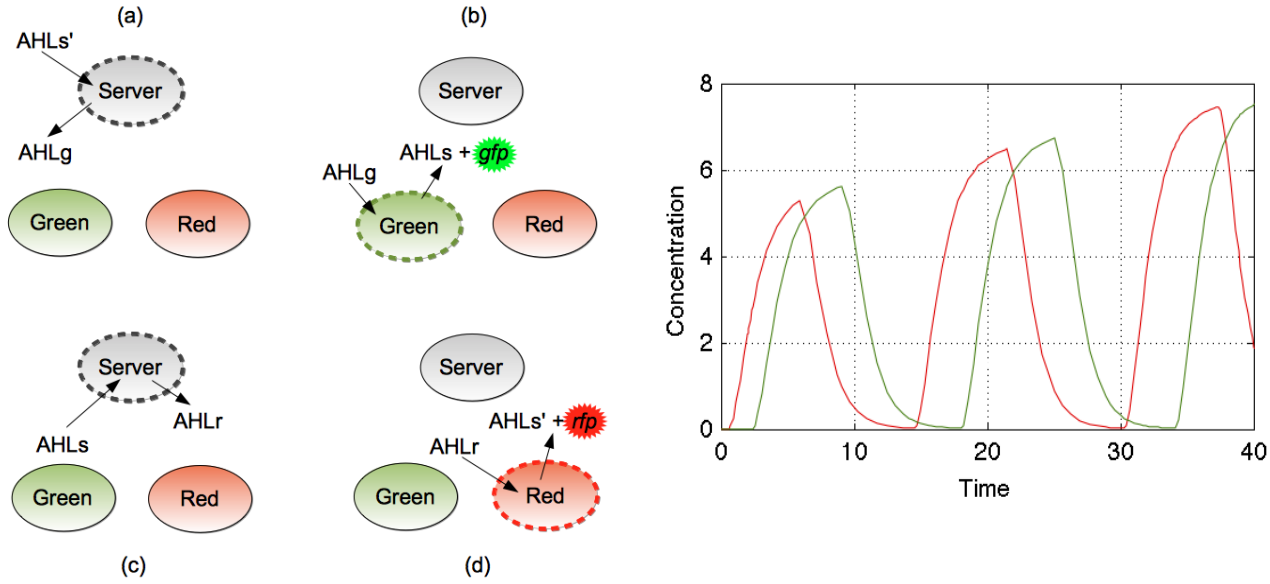

Figure 1: System architecture (left), simulation results (right).

In Figure 1, we show the server and two clients; the *server* is activated by selected signalling molecules, labelled AHLs and AHLs', (producing either AHLr or AHLg respectively); the *green* client is *activated* by AHLg, producing AHLs and green fluorescent protein, and the *red* client is activated by AHLr, producing AHLs' and red fluorescent protein. We can see how this machine lies dormant until either AHLg or AHLr is added to the nutrient, after which one of the clients is activated and the system enters a period of oscillation. This is achieved by the server cells switching “turns” between red and green client cells. We also see the results of system simulations, with plots of AHLs' and AHLs over time.

Our key contribution is the design of the server, which is extremely noise-resistant, and robust in the face of differential client behaviour (e.g., if one client's “off” signal degrades much more slowly than another's). Future work will focus on experimental testing of the system, and investigation of its real-world applicability.

References

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