

On Protocell “Computation”

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Abstract

The EU FP6 Integrated Project PACE (“Programmable Artificial Cell Evolution”) is investigating the creation, de novo, of chemical “protocells”. These will be minimal “wetware” chemical systems integrating molecular information carriers, primitive energy conversion (metabolism) and containment (membrane). Ultimately they should be capable of autonomous reproduction, and be “programmable” to realise specific desired function. A key objective of PACE is to explore the application of such protocell technology to build novel nanoscale *computational* devices. In principle, such computation might be realised either at the level of an individual protocell or at the level of self-assembling, multi-cellular, aggregates. In the case of the individual protocell level, a form of “molecular computation” may be possible in the manner of “cell signalling networks” in modern cells. This might be particularly appropriate where a protocell is deployed to interface directly with molecular systems, such as in “smart drug” applications. “Programming” of molecular computation functionality might be realised by evolutionary techniques, i.e., applying selection to populations of (reproducing) protocells. Reflexive string rewriting systems may provide an appropriate formal model of molecular computation. The behaviour of minimal reflexive string rewriting systems, incorporated in reproducing containers (protocells), is being explored in simulation. This is a basis for possible design of minimal protocell “computers”.

Keywords: Protocell, Evolutionary Computation, Complex Systems.