Programmable Artificial Cell Evolution
PACE

FP6 - IST / FET Integrated Project

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Introduction

Life revolves around real-world information processing, but the gap between computers and living systems is still formidable. The European Commission has approved an **Integrated Project PACE** that will create the foundation for a new generation of embedded information technology using programmable, self-assembling artificial cells.

Distributed intelligent technical systems with self-organizing and evolvable life-like properties are required both to make the next generation of self-repairing computer and robotics technology and to direct all kinds of production and remediation on the nanoscale. The integrated project PACE will focus on the IT potential of truly artificial cells: addressing both the technical opportunities of programmable artificial cells and an evolutionary roadmap to producing them under the control of current computers. Such artificial cells will be useful because of their distinctness from, rather than similarity to current biology.

A consortium of some 13 partners and 2 cooperating groups from 8 European countries, including Switzerland and Lithuania, and several USA organizations will pioneer this new approach under the IST-FET section of the EU 6th Framework Program (FP6).

Approach

The integrated project PACE will explore the utilization of the simplest technically feasible elementary living units (artificial cells much simpler than current cells) to build evolvable complex information systems. We will create, analyse and investigate the applications of such systems that process information by self-organization starting at molecular scales. We will also determine whether life-like properties are necessary for computational systems to be fully robust and adaptive and investigate the tension between evolvable living autonomy and programmable utilization. We will explore the collective properties of artificial cells and demonstrate that they are the right material for building nanoscale robot ecologies. The particular molecular systems we will consider will have genetically controlled catalytic reactions, self-assembly of complex supramolecular structures, and energy transduction. We will investigate the stepwise evolution of such complex systems by machine complementation and combinatorial search using a programmable microfluidic interface. We will provide theoretical and simulation frameworks for understanding emergent computational properties of such systems, and experimental frameworks for programming them by evolutionary exploration of chemical reactions.

Eventual applications

- Programmable construction systems
  (artificial cells structuring space)
- Programmable production systems
  (artificial cells producing components)
- Programmable monitoring and actuator systems
  (artificial cells detecting)
- Programmable repair systems
  (artificial cells working with other structures)
- Programmable messaging systems
  (artificial cells communicating in embedded systems)
- Programmable information processing systems
  (artificial cells computing)