



Coordination of Biological and Chemical IT Research Activities

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Report on first annual COBRA conference

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Introduction

The 1st COBRA Workshop on Biological and Chemical Information Technologies (BioChemIT2011) was held on 8th August, 2011, as part of the European Conference on Artificial Life (ECAL2011).

The meeting was hosted by the Cité Internationale Universitaire de Paris, in France. ECAL is a high-level, biennial conference on the simulation and synthesis of living systems, and has been running since 1991.

The central objective of BioChemIT was to provide a forum to present and discuss the latest advances of Bio/Chem IT research. The workshop was intended to foster interaction, exchange and communication between Bio/Chem IT research groups and projects. It was also designed to contribute to community building, and to provide input to the community consultation activities of COBRA.

Topics within the scope of the workshop included: biological/chemical information technologies; molecular and chemical computing; protocells and synthetic cells; molecular robots; integration of information processing with (bio-)chemical production; nano-bio-info interface; cellular engineering, artificial neurons, and programmable information chemistry; unconventional computing substrates.

Organization

The workshop was advertised via a dedicated page on the main project website (<http://www.cobra-project.eu/biochemit2011.html>), and also on the main ECAL site (<http://www.ecal11.org/workshops/#biochemit>).

Invited lectures were given by S. Frantisek (Institute of Chemical Technology, Prague, Czech Republic) and S. Kernbach (Universität Stuttgart, Germany).

We accepted ten abstracts for oral presentation, including contributions from all four COBRA constituent projects (BACTOCOM, ECCell, MATCH-IT and NEUNEU).

All abstracts are available at <http://www.cobra-project.eu/abstracts> (individual abstracts are also linked in the programme details, below).

The workshop program committee was formed as follows:

- Martyn Amos (Manchester Metropolitan)
- John McCaskill (RUB Bochum)
- Steen Rasmussen (Odense)
- Harold Fellerman (Odense)
- Jerzy Gorecki (Warsaw)
- Angel Goni-Moreno (Manchester Metropolitan)
- Uwe Tangen (RUB Bochum)
- Thomas Maeke (RUB Bochum)
- Gunter von Kiedrowski (RUB Bochum)
- Irene Poli (University Ca' Foscari of Venice)
- Patrick Wagler (RUB Bochum)
- Klaus-Peter Zauner (Southampton)
- Andy Adamatzky (Univ. West of England)
- Peter Dittrich (FSU Jena)
- Maurits de Planque (Southampton)
- Christian Tschudin (Basel)

Programme

The workshop was held as a full-day session on Monday 8th August, from 09:00 to 18:30. The programme was as follows:

Time	
09:00	Welcome
09:15	Invited lecture - Stepanek Frantisek: Challenges and opportunities in the engineering of chemical robots
10:15	Chu: Noise-speed-code trade-offs in gene computers
10:45	Goni-Moreno/Amos: Design of a genetic branch predictor
11:15	Coffee break
11:30	Corsi <i>et al.</i> : BZ oscillations inside lipid-enclosed droplets
12:00	Holley <i>et al.</i> : Computational explorations in BZ mediated geometric vesicle transcriptions
12:30	Lui <i>et al.</i> : Towards an in silico and in vivo Turing Test for Chells

Time	
13:00	Lunch
14:30	Invited lecture - Serge Kernbach: <u>Chemo-ICT and microrobotics: achieving collective intelligence</u>
15:30	King <i>et al.</i> : <u>Towards on-chip on-demand microfluidic production and manipulation of droplets for chemical computing</u>
16:00	Tangen: <u>On the external programming of a self-referential evolving micro-controller system</u>
16:30	Coffee break
16:45	Chaplin <i>et al.</i> : <u>Implementing conventional logic unconventionally: photochromic molecules as registers and logic gates</u>
17:15	McCaskill: Spatially interfaced Chem-IT: towards electronic chemical cells
17:45	Rasmussen: ICT and chembio-based replication
18:15	COBRA discussion session
18:30	Close

The invited lectures were as follows:

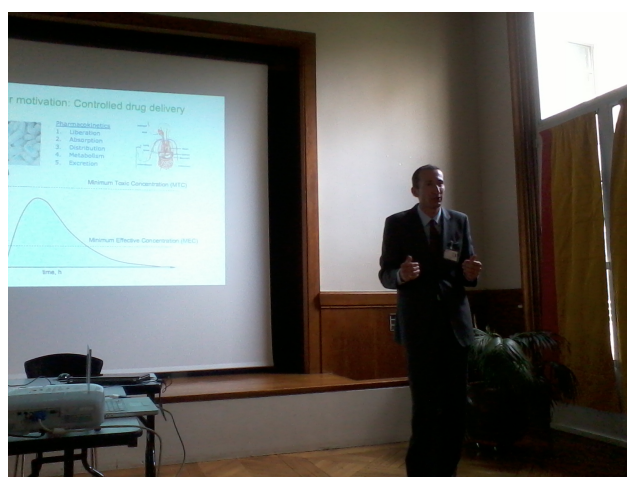
Challenges and Opportunities in the Engineering of Chemical Robots

Frantisek Stepanek

Institute of Chemical Technology, Prague, Czech Republic

<http://www.chobotix.cz>

Classical robots are electro-mechanical machines designed to carry out mainly mechanical tasks in the macroscopic world, such as repetitive manipulation with heavy objects, welding, etc. If we want to miniaturise robots so that they can interact with objects at the 1-10 micrometer length-scale (such as single-cell organisms), a simple scale-down of macroscopic machines using MEMS technologies is not feasible, due to increased effects of colloidal interactions (Brownian motion,



capillarity, van der Waals forces, etc.). Hence, the aim of our work is the design and synthesis of so-called chemical robots, which we conceive as internally structured particles in the 1's-10's μm size range that can freely move in their environment, selectively exchange molecules with their surrounding in response to a local or external stimulus, chemically process those molecules and either accumulate or release the product. In this talk, the following aspects will be covered: (i) architecture and design strategies of chemical robots; (ii) fabrication methods for the synthesis of internal compartments, outer shells, and entire bodies of chemical robots, with special focus on the use of responsive polymer composites and ink-jet technology; (iii) characterisation of the chemical robot's structure and properties; and (iv) use of chemical robots for the controlled release of a chemical payload and their interaction with biological substrates (site-specific targeting). Current and future application areas of chemical robots will be reviewed and challenges for further research outlined.

Chemo-ICT and microrobotics: achieving collective intelligence

Serge Kernbach

Universität Stuttgart, Germany

Miniaturization of microrobotics and advances in chemo-ICT technologies create new challenges for convergence of mechatronic and chemical autonomous systems. Elements of both systems are characterized through very simple "agents", which possess rudimentary sensing, actuation and communication capabilities. However, current and potential applications require a certain degree of intelligent functionality and behavior in these systems, which can be achieved primarily in collective way by utilizing principles of swarm intelligence. This talk gives an overview over the field of microrobotics and intelligent MEMS devices and discussed several approaches of achieving global awareness and intelligent collective behavior in such limited systems.

Participants

Approximately 30 participants attended the workshop, of whom 25 signed their name on the official register:

- Amos, Martyn (Manchester Metropolitan, UK)
- Chaplin, Jack (University of Nottingham, UK)
- Chu, Dominique (University of Kent, UK)
- Corsi, Josephine (University of Southampton, UK)
- De Planque, Maurice (University of Southampton, UK)
- Dittrich, Peter (University of Jena, Germany)
- Flamm, Cristoph (University of Vienna, Austria)
- Goñi-Moreno, Angel (Manchester Metropolitan, UK)
- Gordon-Smith, Chris (SimSoup)
- Gorecky, Jerzy (Institute of Physical Chemistry, PAN, Warsaw, Poland))
- Grünert, Gerd (University of Jena, Germany)
- Holley, Julian (University of the West of England, Bristol, UK)
- Kernbach, Serge (Universität Stuttgart, Germany)
- King, Philip (University of Southampton, UK)
- Korza, Lukasz (Cardinal Stefan Wyszyński University, Warsaw, Poland)
- Kreyszig, Peter (University of Jena, Germany)
- Lenaerts, Tom (Université libre de Bruxelles, Belgium)
- Lui, Leong Ting (University of Nottingham, UK)
- McCaskill, John (Ruhr University Bochum, Germany)
- Packard, Norman (European Center for Living Technology, Venice, Italy)
- Rasmussen, Steen (Fundamental Living Technology (FLinT), University of Southern Denmark)
- Reynaert, Bryan (Universidad Católica, Chile)
- Szymanski, Jan (Institute of Physical Chemistry, PAN, Warsaw, Poland)
- Stepanek, Frantisek (Institute of Chemical Technology, Prague, Czech Republic)
- Tangen, Uwe (Ruhr-University Bochum, Germany)
- Zauner, Klaus-Peter (University of Southampton, UK)

Publication

After the workshop, a call for papers was issued, inviting contributions to a special issue of *BioSystems* dedicated to the meeting.

Photographs



A subset of the participants, at the end of the meeting.



ECAL venue.



During Professor Kernbach's invited lecture.