



Zoltán Muzsnay, Eric Chroystein Morris, Pablo Andres Martinez, Chrystopher Nehaniv, Daniel Schreckling, Gábor Horváth, Zoran Konkoli, Tamás Milkovszki, Thomas Heistracher, Ágnes Bonivárt, Fariba Karimi, Paolo Dini and Ágota Figula

## Editorial

Intensive collaboration inside and increasingly outside the project and intellectual excitement characterized BIOMICS in its final 18 months with a flurry of results and advances challenging the interdisciplinary team of computer scientists, systems biologists, and mathematicians. Advances towards understanding dynamical stability via Hamiltonian quasi-potentials for dissipative systems, stochastic differential equations (with Zoran Konkoli of Chalmers University), and metabolic analysis of structural aspects (independent of rates) in meta-stable biological systems continued in order to link these to computational applications via discrete and category-theoretic constructions.

The team solved a long-standing conjecture on algebraic invariants of graphs and digraphs, indicating that most metabolic and many genetic regulatory networks must have numerous embedded SNAGs (Simple Non-Abelian Groups) endowing them with unconventional computing power based on an alternative to binary logic.

Detailed interdisciplinary analysis and modelling of the cardiac cycle and primitive multicellular organisms with different cell types performing different tasks led us toward the implementation of Interaction Machines in computational proof-of-concept testbeds. This included extending the CoreASM engine with appropriate primitives and functionality to support BSL,

the BIOMICS Biological Specification Language, in collaborations with University of Ulm, so that truly asynchronous distributed computational components can be linked by dynamically changing interaction functions in a newly designed and implemented distributed execution framework architecture. Proof-of-concept implementations of interaction machines mapping growth and death of computational cells for adaptive resource deployment were achieved in dynamically stable self-modifying examples, including load-balancing software inspired by the life-cycle of multicellular filamentous organisms with differentiated cell types.

**Project Coordinator and Co-Coordinator**  
Paolo Dini and Chrystopher Nehaniv (UH)

## London Maths Society (LMS)

29 October 2014



Paolo Dini, Ágnes Bonivárt, Chrystopher Nehaniv, Fariba Karimi,

The University of Hertfordshire (UH) team attended the LMS Computer Science Colloquium on Computational and Mathematical Modelling for Improved Understanding of Biological Systems. Luca Cardelli from Microsoft Research Cambridge and Netta Cohen from Leeds University were among the speakers. Very interesting and inspiring event.

[http://www.ima.org.uk/\\_db/\\_documents/CS%20Day%20poster%20v2.pdf](http://www.ima.org.uk/_db/_documents/CS%20Day%20poster%20v2.pdf)

## Lie Groups Meeting, Debrecen

10-12 December 2014



Eszter Gselmann, Paolo Dini, Gábor Horváth and Ágnes Bonivárt

Paolo Dini and Ágnes Bonivárt attended a meeting hosted by the University of Debrecen to discuss a model of the mutual inhibition toggle switch and look for Lie symmetries to solve it. However, the model was too complex and we could not find any Lie symmetries.

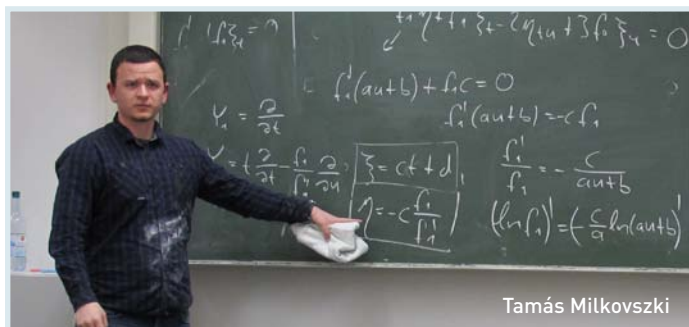
## Third BIOMICS Workshop at the University of Passau in Germany

**8-10 February 2016**

In addition to 15 multi-lateral and 2 plenary meetings, we also held our **Third BIOMICS Workshop**. The main purpose of this workshop was to enable project partners to present the main findings from the third and last year of BIOMICS research to each other and to external guests, especially from the Interaction Computing Research Network (ICRN) and the UCOMP cluster. The workshop was a very constructive exchange of ideas, disciplinary languages and perspectives and cultural interactions.



Gábor Horváth



Tamás Milkovszki



Christopher Nehaniv



Eric Rothstein



Prof Zoran Konkoli, Chalmers University, Sweden



Daniel Schreckling

The Workshop was hosted by University of Passau in Germany from the 8th to the 10th of February 2016.

Participants said it provided a solid platform for the BIOMICS researchers to come together one final time before the funded life-time of the project, update one another on each of the research deliverables, and collaborate even more closely for the final few months of the project. The partner institutions were represented by 11 BIOMICS researchers over the two days.



Daniel Schreckling, Eric Rothstein, Ágota Figula, Thomas Heistracher from SUAS, Gábor Horváth, Zoltán Muzsnay, Ágnes Bonivárt, and Pablo Andres Martinez

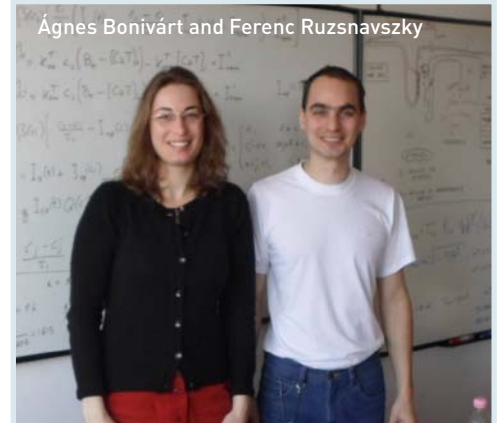
## Groups and Topological Groups Conference

13-14 February 2015



On 13-14 February, 2015 the international conference called "Groups and Topological Groups 2015" (GTG2015 for short) was held in the Institute of Mathematics, University of Debrecen, Hungary and was supported by the BIOMICS project. The conference delivered the latest results in group theory, Lie theory and related topics. Out of the 29 participants, 22 gave talks, including members of the BIOMICS project, e.g. Prof. Chrystopher Nehaniv,

Dr. Fariba Karimi or Dr. Zoltán Halasi. The conference was a great success and many of the talks inspired discussions afterwards. Some of these are closely related to BIOMICS, e.g. Permutation groups associated to a complete invariant of finite graphs given by Chrystopher Nehaniv or Coproducts for groups and semigroups acting on pointed sets by Fariba Karimi.



Ágnes Bonivárt and Ferenc Ruzsnaszky

The conference schedule, the list of participants and the abstracts can be downloaded from the conference website at <http://math.unideb.hu/figula-agota/gtg2015.html> During the same meeting Paolo Dini and Ágnes Bonivárt met with Ferenc Ruzsnaszky from the University of Dundee to discuss the modelling of the Calcium cycle of cardiac myocytes (heart muscle cells).

## Calcium Cycle Meeting, Hatfield

16-17 March 2015



Ágnes Bonivárt, Chrystopher Nehaniv, Eric Rothstein and Egon Börger

On 16-17 March 2015 UH hosted a meeting to discuss the computational modelling of the Calcium cycle with Abstract State Machines. Professor Egon Börger (University of Pisa and University of Passau) came with Eric Rothstein from UNI PASSAU, and Ferenc Ruzsnaszky came from UNIVDUN. Ferenc delivered a lecture on the intricacies of the Calcium cycle, and Prof Börger explained some of the basic concepts of ASMs.

## Attila's visit to Hatfield

June 2015



Paolo Dini, Ágnes Bonivárt, Chrystopher Nehaniv, and Attila Egri-Nagy

Attila Egri-Nagy visited UH again in Summer 2015 and worked with Chrystopher Nehaniv on developing an understandable, efficient, and streamlined proof of the Holonomy Decomposition for finite transformation semigroups and automata.

Nehaniv presented their work illustrated with computational examples at the AMS-EMS-SPM International Meeting 2015, 10-13 June, in Porto, Portugal.

During the visit they used the new method to improve our SgpDec software package for the GAP computer algebra system, and were both invited participants speaking at the prestigious London Mathematical Society - Engineering and Physical Sciences Research Council (LMS-EP SRC) Workshop on "Permutation Groups and Transformation Semigroups", Durham University, U.K 20-30 July 2015 organized by P. Cameron, D. MacPherson and J. Mitchell.

## TRUCE Summer School, Malaga

**31 August-4 September 2015**

Paolo Dini attended the 2nd TRUCE Summer School as a teacher and gave a lecture titled 'An Interdisciplinary Overview of Interaction Computing'. Several partners from the UCOMP cluster also gave lectures. There were approximately 30 students from all over Europe.

<http://www.truce-project.eu/2015-summer-school.html>

## Lie Groups Meeting, Debrecen

**9-12 September 2015**



Ágnes Bonivárt, Tamás Milkovszki, Ágota Figula, Károly Podosky, Zoltán Muzsnay, Paolo Dini, Gábor Horváth

Paolo Dini and Ágnes Bonivárt attended a meeting on Lie group methods for solving differential equations at the University of Debrecen.

It was a very interesting tutorial where the Debrecen team explained how they had found a group of symmetries for a large class of differential equations, originally inspired by nerve conduction (Fitzhugh-Nagumo model)

## Latest BIOMICS Publications

The BIOMICS project team published 38 Journal articles, 52 Conferences and Workshops papers. You can view them on the BIOMICS website at :

<http://www.biomicsproject.eu/public-publications>

