



ECCS'11 Satellite Meeting

on

**Complexity-NET projects: Interdisciplinary
Challenges for Complexity Science**

FET proactive 4: COSI-ICT Projects

**Thursday 15th September
Seminarraum 3 (Anglistik)
Campus University of Vienna
Spitalgasse 2
1090 Vienna
Austria**

Interdisciplinary Challenges for Complexity Science

Complexity-NET's pilot call for research proposals, entitled *Interdisciplinary Challenges for Complexity Science*, was launched on 8 May 2009. Ten of the eleven Complexity-NET partner funding agencies were able to take part in the call, which also included two further funding agencies, FWO and BELSPO, both from Belgium. The call was administered by the NWO (Netherlands) using a two-stage peer-review process. The call partners selected a panel of distinguished science experts, known as the Scientific Council, to assess the proposals at each stage.

The aim of the call was to support collaborative, interdisciplinary research projects on approaches with the potential to bring new insight to important problems in real-world complex systems. Applicants were not limited to specific challenge domains, but all proposals had to address clearly at least one of three broad, complexity-related themes:

- Emergence and self-organisation, individual to collective behaviour, micro to macro;
- Dynamics and (un)predictability, risk and extreme events;
- Resilience, sustainability, management and control of complex systems.

As well as national promotional activities, a brokerage event was organised in Brussels in May 2009 to publicise the call, inform potential applicants, and facilitate the creation of new transnational research teams through networking activities. Nearly 100 invited scientific researchers participated in the event; each call partner agency was allocated ten places for their own invitees. Prominent scientists gave short talks on the most recent developments in the field of complex systems and complexity science, while round-table discussions were organised on the themes of the call.

In the first peer-review stage, expressions of interest were solicited with a closing date of 30 July 2009. 117 proposals were received, of which 101 met all Complexity-NET and national eligibility criteria. The expressions of interest were assessed by the Scientific Council at a meeting held in The Hague in September 2009. 28 applicant teams were invited to submit a full proposal by a second closing date of 1 December 2009.

In the second peer-review stage, the 28 full proposals received were sent to well-known complex systems researchers outside the call consortium territories for review. The anonymous reviews obtained by NWO were sent to the Principal Investigators, who were given the opportunity to respond in writing to any issues raised by the reviewers. The full proposals, review documents and PI responses were assessed by the Scientific Council at a meeting held in March 2010, and 15 full proposals were recommended for funding.

The pilot call consortium of funding agencies met in April 2010 to decide which of the recommended proposals could be funded. The pilot call was managed using a virtual common pot, which meant that a proposal could only be funded if each funding agency involved had sufficient funds to support that project. Ultimately nine proposals could be supported, involving all ten nationalities represented in the call and eleven of the twelve participating funding agencies. The successful projects will be presented during this session. More information about Complexity-NET can be found on the website (www.complexitynet.eu).

WHAT IS COSI-ICT ?

Objective ICT-2007.8.4:

FET proactive 4: Science of complex systems for socially intelligent ICT (Extract from Work programme text)

Target outcome:

Key concepts and tools for a data-intensive science of large scale techno-social systems, i.e., systems in which ICT is tightly entangled with human, social and business structures which, as a result, mutually transform each other for instance through evolution of acceptance, trust, innovative uses and technology changes. Projects will develop systematic means to gain knowledge on such systems and to model, predict and characterise their behaviour, their dynamics and evolution. They will demonstrate the use of this understanding in novel paradigms and designs for socially intelligent ICT. Projects will integrate the following topics:

- **Theoretical and algorithmic foundations** for scaleable modelling and simulation of such multi-level systems, taking into account the relevant technological, psychological and social dimensions and with realistic diversity of behaviours, social and spatial structures and knowledge on how humans and technologies relate to and impact on each other (e.g., acceptance, use, trust).
- **Data-driven simulation**, tools and techniques able to cope with huge sets of heterogeneous and often unreliable data to efficiently reconstruct dynamic system models at multiple levels. This includes data-rich probing technologies, protocols and experiments to gain realistic data on techno-social systems, and knowledge extraction based on scaleable and distributed methods.
- **Prediction and predictability**: mathematical and computational methods that help to characterize the nature and impact of transitions, novel properties and self-organising effects that can occur as systems massively scale up. . Understanding the limits of predictability will allow reliable, quantitatively accurate predictions leading to strategies for better guided ICT induced transformation or for keeping systems in their viability domain.

Coordination actions (CAs) should support the consolidation of research communities, their visibility, the coordination of research agendas, the coordination of national or regional research programmes or activities. The initiative also encourages international cooperation in foundational research on topics described above.

Expected impact:

This research should contribute to a new multidisciplinary understanding of the ways in which ICT changes, moulds and becomes part of the systems to which it is applied, and lead to better targeted deployment of socially intelligent ICT systems. Breakthroughs will lead to deeper understanding and the ability to predict and design for instance new generations of autonomous information- or high-bandwidth communication systems by exploiting models of self-organisation, adaptability and social behaviour. Applications include e.g., massive service economies and other technology-dependent experimental economic models, ICT mediated communities, P2P systems, emergency management and disaster relief systems. Projects should indicate how efficient data gathering, simulation, prediction and control techniques can lead to more human-centric systems, can harness collective intelligence or behaviour, can support businesses and policy makers with best practices that have a clear and definable societal and economic added value or can contribute to solving long-term challenges such as sustainable growth, energy efficiency, or social inclusion.

Schedule

- 9.00 **Dr Carolina Cronemberger**, Multi-objective optimization for modeling developmental gene regulatory networks (MOPDEV)
- 9.20 **Dr Anders Johansson**, Complexity in Spatial Dynamics (COSMIC)
- 9.40 **Dr Sabine Lennartz**, Localizing signatures of catastrophic failure – LOCAT
- 10.00 **Prof. Rosaria Conte**, Simulating the EMergent Impact of Regulations Across cultures (SEMIRA)
- 10.20 **Dr Alef Sterk**, Predictability of Extreme Weather Events (PREDEX)
- 10.40 **Karthika Raghavan**, Applying Computational Epigenetic Micromodel to predict Colon Cancer
- (11.00 - 11.30 coffee break)
- 11.30 **Prof. Tassos Bountis**, Advances in Complex Matter Research
- 11.50 **Dr Joachim de Beule**, Emergence and Evolution of Biological Symbol Systems (EvoSym)
- 12.10 **Dr Mara Baudena**, Resilience and interaction of networks in ecology and economics (RESINEE)
- 12:30 **Prof. Dr. Janusz Hołyst**, the COSI-ICT project CyberEmotions
- 12:50 **Dr Daniela Paolotti**, the COSI-ICT project Epiwork

Jaap A Kaandorp



Jaap A. Kaandorp perceived his MS, with distinction, in biology (main subject marine biology) in 1985 and a PhD (subject modelling growth and form of marine organisms) in computer science And mathematics in 1992, both from the University of Amsterdam. He has worked from 1985-987 as a researcher at the Centre of Computer Science and Mathematics in Amsterdam. In 1992 he did research as a postdoctoral fellow, on a Government of Canada Award, at the Department of Computer Science of the University of Calgary in Canada. Currently he works as an associate professor at the Section Computational Science of the Faculty of Mathematics, Computer Science, Physics & Astronomy of the University of

Amsterdam. His research interests are: morphogenesis, marine sessile organisms, evolutionary processes, modelling and simulation of developmental regulatory networks and metabolic pathways, modelling and simulation of growth and form, biomechanics.

Carolina Cronemberger



Carolina has received her PhD in Physics in 2009 in Brazilian Center for Physics Research (CBPF, Brazil). Her thesis was about simulation in Deposition of Metals with Fractal structures. During her studies she worked for 1,5 in Institute Neel (Grenoble, France) with the supervision of Prof. P. Molho. Since February 2010, she is working as a postdoc in the group of Jaap Kaandorp in the University of Amsterdam. There she develops, together with Lotte Huisman, a spatial model for calcification in scleratinian corals.

Multi-objective optimization for modeling developmental gene regulatory networks

J. Kaandorp¹, J. Jaeger², F. Alves³, L. Huisman¹, C. Cronemberger¹

¹Section Computational Science, Faculty of Science University of Amsterdam

²EMBL/CRG Research Unit in Systems Biology, Centre for Genomic Regulation (CRG)

³Center for Developmental Biology, Instituto Gulbenkian de Ciencia

One of the most spectacular developments in modern biology is the discovery of gene regulatory networks involved in pattern formation during embryo development. An important next step is to understand the regulatory structure and dynamics of these networks; this will lead to fundamental new insights in developmental biology, evolution and eventually to new medical applications. Disruptions in regulatory networks play an important role in developmental malformations and diseases such as cancer.

Most of these networks are characterized by very complex regulatory structures. An additional difficulty is that network dynamics vary across space and time and are influenced by biomechanical events. A simple graph representation showing the connections between genes does not provide insight into the dynamical behaviour of such complex regulatory systems. Instead, detailed dynamical models will be required. However, obtaining such models is not straightforward. First of all, it is often not clear which network-modelling formalism should be used. Due to the biochemical complexity of eukaryotic transcription, it is currently impossible to derive network models from first principles. Instead, many phenomenological formalisms have been used, from Boolean models to differential equation models approximating transcriptional dynamics with sigmoid functions to stochastic formalisms.

Another important challenge is the determination of model parameters. Even models of moderately sized networks contain a large number of parameters, which determine production, diffusion and decay rates as well as regulatory interactions—or the regulatory topology of a gene network. These parameters are often difficult (if not impossible) to measure. This can be due to the optimization problem being ill-posed or insufficiently constrained by data. Alternatively, parameters can be difficult to determine due to correlations between them. Model validation based on additional experimental evidence is required to decide, which of the alternative mechanisms is applicable to the real biological system. This is often time consuming and technically challenging.

Usually, the accuracy with which a model reproduces observed expression patterns is measured by a cost function based on the sum of squared differences between model and data (single-objective optimisation). Here, we propose to take advantage of the fact that pattern formation must proceed reliably in the presence of molecular fluctuations, genetic variability and environmental perturbations. In other words, realistic patterning mechanisms are robust, and robustness should be considered when fitting models to data.

In this project, we are using multi-objective optimisation for a careful comparison of the performance of three distinct network modelling formalisms applied to the study of realworld developmental gene regulatory networks. We are working with three different organisms: *Nematostella vectensis*, the butterfly *Bicyclus anynana*, and the fruit fly *Drosophila melanogaster*, which vary vastly in their quality, coverage and resolution.

Dr Anders Johansson



Dr Anders Johansson is a Senior Research Associate at the Centre for Advanced Spatial Analysis (CASA), University College London (UCL), an external examiner at the International Centre for Crowd Management and Security Studies, New Buckinghamshire University, and Chief Technology Officer at Crowd Vision Ltd. After MSc studies in Electrical Engineering and Complex Adaptive Systems at Chalmers University of Technology (2000-2004), Anders Johansson joined the Transportation Modelling and Econometrics group at Dresden University of Technology (2005-2007), as a Research Assistant on crowd modeling and received a PhD with Summa Cum Laude distinction. After that, he spent nearly three years at ETH Zurich, as a Lecturer and Postdoctoral Researcher, doing research and teaching in crowd modelling, game theory, traffic modeling, and social simulation.

He has been cited and appeared several times in mass media, news items, documentaries, reports, and magazines such as the Discovery Channel, Nature, and Science, for example. He received a distinction from HRH Prince Miteb bin Abdul Aziz Al Saud, Minister of Municipal and Rural Affairs, Saudi Arabia in 2007 and he was awarded the inaugural Crowded Places Award at the Global Security Challenge in 2008. Anders Johansson is author of the book *Data-Driven Modeling of Pedestrian Crowds*. VDM Verlag Dr. Mueller 2009.

See www.ajohansson.com for more information.

Complexity in Spatial Dynamics (COSMIC)

A. Johansson*

University College London, London, UK

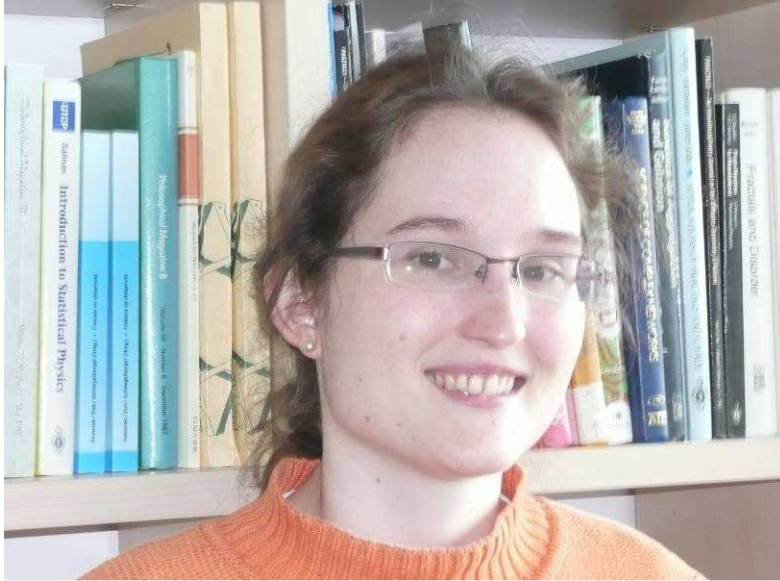
COSMIC (COmplexity in Spatial dynaMICs) is a project linking three research groups: Spatial Economics at the Free University of Amsterdam (VU), The Centre for Advanced Spatial Analysis (CASA) at University College London (UCL), and the National Centre for Geocomputation (NCG) at the National University of Ireland at Maynooth (NUIM). These centres all deal with quantitative urban science and geo-spatial analysis, and have expertise in complexity science applied to urban and regional systems.

COSMIC is a network which will tie these groups together and establish some momentum for research into urban dynamic processes using new bottom up, digital data collected for entire populations using web 2.0 technologies such as crowd-sourcing, GPS and more conventional data mining of large electronically available spatial data sets concerning social and economic transactions and interactions. We believe that such data will provide dramatically new insights into urban change which manifest themselves in often discontinuous forms which can be articulated using a variety of reaction-diffusion dynamics incorporating catastrophe, chaos, bifurcations, and phase transitions. In cities, such reactions range from the emergence of edge cities to patterns of residential segregation, embodying social exclusion in various forms.

The project will first develop a typology of urban dynamic processes to guide the development of models using new digital data collected in real time from electronic transactions such as phone lines, electronic ticketing, and related geo-sensing. Our unifying focus will be on flow data associated with underlying networks with the models revolving around spatial interaction and movement from labour markets to pedestrian movement. VU will explore methods for estimating dynamic models of labour markets in Germany and urban navigation in Amsterdam, UCL will develop models of movement and location from phone and ticketing data in London, while NUIM will explore movement at in small scale environments represented at the building and streetscape scale in Dublin.

The network will be supported by three major workshops, exchanges of researchers between sites, and strong external links to other groups, in anticipation that from this pilot project, a proposal for a much wider network will emerge. COSMIC like all the Complexity-Net initiatives is designed not only to indulge the interests of the researchers involved but also to widen these ideas to the European community of complexity scientists and beyond. External links to groups dealing with urban complexity around the world will be strengthened and besides the usual deliverables of such a project, papers, demonstrations, web dissemination, the pilot project will lead to a proposal for wider programme of work in this domain.

Sabine Lennartz



Sabine Lennartz is an expert in time series analysis and works since 2011 as a research fellow at the School of Engineering and the School of Geosciences at the University of Edinburgh, Scotland. She studied physics in Cologne, Germany, and moved for her PhD in Theoretical Physics to Giessen, Germany. 2009 she finished her PhD about “Correlation- and trend analysis in short records: Applications in climatology and seismology” with excellence and received 2010 the Donald L. Turcotte award from the Nonlinear Geophysics Focus Group of the American Geophysical Union.

Localizing signatures of catastrophic failure – LOCAT

S. Lennartz*, M. Zaiser, I. Main, I. Butler, S. Zapperi, and F. Kun

University of Edinburgh, Edinburgh, UK

Large-scale catastrophic failure events such as earthquakes have a very complex nature. Different forces are interacting with different materials on both microscopic and macroscopic scales. The local properties and their distributions are not well known, and the interactions between the large number of components are still not fully understood, making prediction of individual large earthquakes difficult, if not impossible. In this project we concentrate on finding localizing signatures of catastrophic failure. Therefore, we study not only real earthquakes, but also (i) laboratory experiments, where we put pressure on rocks and measure acoustic emissions, and (ii) modeled data like the avalanches on a random fuse network. These systems show the same features as real earthquakes, e.g. the Gutenberg-Richter (scale-invariant) distribution of the size of the avalanches, and a similar complexity. But here we have the advantage, that, in contrast to real earthquakes, we know several system parameters like the system size, or the applied stress, and in the numerical models even the detailed local parameters of the system elements. We are interested in how possible localizing processes and their signatures depend on or affect the bulk parameters on a range of scales in space and time. This multi-scale, multi-physics approach may give an insight in why such localizing signatures, common under controlled laboratory conditions, are rarely observed prior to real earthquakes. At a minimum we conclude that the scale-invariant nature of the geometry of fracture systems cannot be taken as evidence for linear scaling of physical processes from the laboratory to the natural case.

Rosaria Conte



Rosaria Conte is head of the Laboratory of Agent Based Social Simulation at the ISTCCNR in Rome, President of the Italian Cognitive Science Association (AISC), and President of the European Social Simulation Society (ESSA). She has been teaching Social Psychology at the Univ. of Siena until 2009. Tutor of (Inter)national Fellowships and PhD students, she is now a member of the newly established Rome Node of the Centre of Interactive Intelligent Systems (CIIS) of the Univ. of Plymouth, UK. She published 136 works among volumes, papers in scientific journals, conference proceedings, and book chapters. Her scientific activity aimed to (a) explain prosocial behaviour among intelligent autonomous systems, including altruism and norm-based action and (b) model the bidirectional dynamics of norms and norm-enforcement mechanisms (including reputation and gossip). Her research is characterised by a highly interdisciplinary approach, at the intersection among cognitive, social, and computational sciences, and an innovative, computational methodology based on agent based social simulation (ABSS).

Simulating the EMergent Impact of Regulations Across cultures (SEMIRA)

R. Conte*

CNR Institute of Cognitive Sciences and Technologies, Rome, Italy

The SEMIRA project studies the interaction between emerging normative behaviour and new regulations in different cultures and different countries. The goal is to support the preparation of new regulations of different government bodies. Two types of agent-based simulation tools are being developed. One tool will validate the theoretical framework with actual people. The other will do large scale simulations based on emergent behaviour. The novelty in this approach is twofold. We will combine simulations with a few rich agents and simulations with many simple agents. Based on this rich (but computationally expensive) model we will build simulations with simple agents that will abstract away many of the details needed for the virtual environment simulation. The second novelty is that we will look at a combination of emergent patterns of behaviour that come from individual decisions in an environment with (new) imposed regulations and rules of behaviour that are inherent in the culture of the society. Hence, we simulate a combination of top down and bottom up changes of behavioural patterns.

The new smoking legislation in bars and restaurants is our use case. So far, cultural influences on individual decision making have been modelled, linking dimensions of culture to normative behaviour. Secondly, the implementation of social norms has been linked to the OCC emotions model in the FATiMA architecture, which is the virtual environment model that can (in)validate our behavioural assumptions with real people. Thirdly, the role of normative sanctions in contrast to a purely cost based enforcement mechanism has been investigated in a large-scale simulation of emergent behaviour.

Dr Alef Sterk



Dr Alef Sterk is Associate Research Fellow at the University of Exeter, where he works on the predictability of extreme events in models of the atmosphere. He received his PhD degree from the University of Groningen in October 2010. In his thesis he studied the dynamics of simplified models for low-frequency phenomena in the atmosphere and ocean. Alef is interested in the mathematical theory of Dynamical Systems and its applications to climate science.

PREDEX: Predictability of Extreme Weather Events

A.E. Sterk*, P. Rabassa Sans

University of Exeter, Exeter, UK

Classical extreme value theory is concerned with the distribution of the maximum over a collection of random variables. This theory can be applied to a process generated by a (chaotic) deterministic system composed with an observable quantifying the event intensity. This is the basic idea behind the extreme value theory for chaotic deterministic dynamical systems, which is a rapidly expanding area of research.

PREDEX is an interdisciplinary project which delivers new mathematical techniques to quantify the predictability of extreme events in complex systems. In this talk we present two recent accomplishments of PREDEX:

1) The observables which are typically studied in the literature are expressed as functions of the distance with respect a point within the attractor. However, physical observables, such as windspeed or vorticity in atmospheric models, are not of this form.

We consider extreme value limit laws for observables which are not necessarily functions of the distance from a density point of the dynamical system. In this case, the limit law is no longer determined by the functional form of the observable alone, but it also depends on the local dimension of the invariant measure and the geometry of the underlying attractor.

2) Extreme value theory does not address the finite-time predictability of extreme events in deterministic systems. We develop concepts based on error growth rates to study the finite-time predictability of extreme wind speeds in atmospheric models. Such extreme events are less predictable than generic events.

Karthika Raghavan



Karthika Raghavan is a post graduate research student doing her PhD (final year) in Computing, at a highly research inclined laboratory called Center for Scientific Computing and Systems Modelling - SCI SYM , under Prof. Heather J Ruskin, at the Dublin City University (DCU), Dublin, Ireland. She is from Chennai, India, where she completed her Bachelor of Technology (B.Tech.)- Bioinformatics, at SRM University (SRMU), in 2009. Her research focus is towards studying Complex Biological systems, and more recently, applications of Parallel Computing

She is a part of the collaborative project -- "Complex Interdependent Epigenetic Signals in Cancer Initiation" (CIESCI), between the Centre for Scientific Computing & Complex Systems Modelling, (Sci-Sym), Dublin City University in Ireland, Bellvitge Institute for Biomedical Research, (IDIBELL) in Spain and Bioinformatics group, (BIIT), Dept. of Computer Science, University of Tartu/Estonian Biocentre.

Her work in this project involves developing integrated/hybrid models, (combining agent-based and network approaches) across several scales, to incorporate different complex molecular events and understand how these successively combine to affect gene expression that ultimately, influence the phenotype of an organism during normal and abnormal conditions such as Cancer initiation.

Applying Computational Epigenetic Micromodel to predict Colon Cancer

K. Raghavan*, H.J. Ruskin

Dublin City University, Dublin, Ireland

Phenotype or the visible traits of an organism are influenced by 3 main factors, namely surrounding environment, genotype (or genetic content), and, chemical changes to the DNA molecules and proteins associated to these, without altering the actual contents - a phenomenon, known as Epigenetics. Characterization of the epigenetic profile of humans, followed by sequencing the human genome contents, has identified the key role of histone modifications (HM) and stable DNA methylation (DM) in determining gene expression levels. DM refers to the modification of cytosine base molecules and is the most stable, heritable and well-conserved epigenetic change. Aberrations in DM, specifically hypo/hyper methylation was the first such change to be linked to cancer. Histone proteins, apart from protecting and managing DNA molecules, form, with these, the basic unit of nucleosomes in the human genome. A combination of dynamic modifications within specific amino acids in each histone, together with DNA methylation, leads to activation or suppression of genes. While new findings on the impact of DM and HM are reported, precise information on the nature of complex interactions between DM and the network of histone modifications during normal and disease conditions (such as cancer), is lacking.

Such motivations have initiated attempts to build computational models, to represent the molecular events and investigate their intrinsic interdependency. This helps to understand how information is passed from basic, sub-cellular layer to produce effects at tissue and organ level. Here, we discuss about the developments, to a prototype model with novel framework for integration of epigenetic information from different sources. The comprehensive layout of this model permits stochastic investigation of dynamic histone modifications and inherent DNA methylation associated with patterns in DNA sequences, (derived from signal processing methods). The model is tested with a large dataset containing a network of genes known to be associated with colon cancer through epigenetic events, (obtained from specialized epigenetic databases). This application aims to address issues of scale and relevance at phenotype level from the genome containing aberrant molecular changes during cancer initiation. Up scaling techniques (parallelization) used to test large datasets are also explained.

Tassos Bountis



Anastassios (Tassos) Bountis is Professor at the Department of Mathematics, University of Patras, since 1990. He is the director of the Center for Research and Application of Nonlinear Systems University of Patras, <http://www.math.upatras.gr/~crans>. He was the recipient of Academy of Athens Award G. Fwteinos for “Dynamical Systems” in 2009. He obtained his Ph.D. degree in Physics from the University of Rochester, N.Y. , in 1978, and has worked at CalTech in 1979 and as Assistant and Associate Professor at Clarkson University in the U.S.A. until 1986. He has been invited researcher in several countries in Europe, Mexico, India, Japan and Brazil. His research has been supported by many U.S., European and Greek grants, most recently by an ERA-Complexity NET project, called “Complex Matter” involving the University of Patras and groups from the Universite Libre de Bruxelles, the University of Twente, Netherlands and the University of Manchester (<http://complexmatter.wordpress.com>). He has organized 4 international conferences and 22 Summer Schools on “ Nonlinear Dynamics and Complexity” and the 1st PhD School on “Mathematical Modeling of Complex Systems”, 18 – 29 July, 2011 at Patras, <https://www.math.upatras.gr/~phdsch11>. He has authored 5 books in Greek and one in English, “Complex Hamiltonian Dynamics” (Springer Synergetics, 2011). He has supervised 15 M.Sc. theses and 14 Ph.D. theses and is on the Editorial Board of 4 International Journals. He has published 120 papers in refereed journals and 46 in conference proceeding, with more than 1500 citations by other authors, h-index: 23, g-index: 37. <https://www.math.upatras.gr/~bountis>).

Advances in Complex Matter Research

T. Bountis*

University of Patras, Patras, Greece

In this presentation we report on recent advances in critical phenomena and collective behaviour of multi-particle complex systems (Complex Matter for short) as they are pursued in a collaborative European research project joining 4 groups at the University of Patras, Greece, Free University of Brussels, Belgium, University of Manchester, UK, and University of Twente, The Netherlands (see <http://complexmatter.wordpress.com>). The main objectives of the project are: (a) to elucidate how the properties of individual particles, their interactions, and fluctuations at the small scale lead to spontaneous structure formation and collective dynamics at the large scale, (b) to develop a unified approach for systems whose constituents range from nano-particles to millimeter-sized grains, bridging the gap between quantum mechanics and the macroscopic world, and (c) to propose solutions for real-world problems such as the industrial processing of granular matter and the formation of traffic jams.

In particular, the Patras team has been working on the phenomenon of clustering of granular matter. The spontaneous occurrence of dense clusters constitutes a major problem in industries around the world handling granular particles (mining, food production, pharmaceutical industry, construction works, chemical reactors, etc.) and also in vehicle traffic, where the clusters are known as jams.

The Brussels team has obtained interesting results in phase transitions due to matter confinement in small cavities. The prediction of these properties is important in areas such as microfluidics, nano-scale technology and biomedical applications. The same issues arise in larger systems such as colloids and granular materials under conditions of confinement.

The Manchester team has produced fascinating experimental results on self-organized segregation in bidisperse media. The transition from the mixed to the segregated state in a horizontally vibrated monolayer of a mixture of two kinds of granular particles is known experimentally to constitute a second-order phase transition. There have been many attempts to model this phenomenon numerically but to date the experimental findings have not yet been reproduced.

Finally, the Twente team has been studying the Leidenfrost state – a close-packed cluster of slow particles floating on top of a low-density gaseous layer of fast-moving particles –, which was recently shown to undergo a transition to counter-rotating rolls similar to Rayleigh-Bénard convection.

A key difference between the above forms of multi-particle (granular) matter and continuous media is that in the granular case patterns typically emerge on the scale of several tens of particle diameters and fluctuations are not merely present but play a dominant role in the dynamics of these systems. To understand how fluctuations operate under these circumstances is crucial, not only for granular matter, but for all multi-particle systems far from equilibrium where statistical noise, dissipative interactions and fluctuations go hand in hand to produce spontaneously emerging structures.

Joachim De Beule



Joachim De Beule obtained his degree in engineering and physics from Ghent University, Belgium, in 1997. After performing two years of research in nuclear physics and one year in automatization and control theory (both at Ghent University), he started a PhD at the Artificial Intelligence lab of the Vrije Universiteit Brussel (VUB), under the guidance of Luc Steels. In 2007, he obtained his PhD on the evolution of compositionality in natural and artificial languages. In 2010, he moved to the Artificial Intelligence lab of the Universite Libre de Bruxelles (headed by Hugues Bersini and Marco Dorigo) to work on the usage of wikipedia for the automatic classification and clustering of text-documents. In 2011, he returned to the VUB Artificial Intelligence lab where he is currently teaching several master courses in artificial intelligence as well as continuing his research on the emergence and evolution of codes and the role of communication in the evolution of complexity for the Evosym Complexity-NET European project. He also became a member of the editorial board of the Biosemiotics Journal and was invited to become one of the first Young Scholars at the Stellenbosch Institute for advanced Study in South Africa.

Emergence and Evolution of Biological Symbol Systems (EvoSym)

J. de Beule*

Vrije Universiteit Brussel, Brussels, Belgium

EvoSym is a collaborative project bringing together complexity researchers in Ireland, the Netherlands and Belgium. It is investigating two key questions:

- How do complex representational and communicative coding systems emerge, self-organise and evolve, from micro to macro levels, in the natural biosphere?
- How can this biological understanding be applied to the artificial evolution of complex coding systems in computational and/or robotic systems?

The project will apply methods and techniques of complexity science to understand the emergence and evolution of biological "symbol systems" (also called "biosemiotic systems"), such as genetic coding (DNA-protein), RNA editing, cell signaling, etc. It will also investigate potential technological applications in distributed agent-based software and robotics.

The project is organised in three major work packages:

- WP1 will build on previous work in modeling prebiotic molecular evolution in spatially extended individual-based systems. It focuses on how "RNA coding" could evolve in such an environment.
- WP2 will investigate the origin and evolution of evolvable coding and translation in purely computational systems.
- WP3 will apply principles of language evolution in collective robotic systems to the emergence of complex languages in models of chemical communication among biological cells.

The EvoSym project partners are:

- Artificial Life Lab, Rince Institute, Dublin City University, Ireland. Principal Investigator: Prof. Barry McMullin.
- Bioinformatics Group, Universiteit Utrecht, Netherlands. Principal Investigator: Prof. Paulien Hogeweg.
- Artificial Intelligence Laboratory, Vrije Universiteit Brussel, Belgium. Principal Investigator: Prof. Luc Steels.

Project website: <http://evosym.rince.ie/>

Mara Baudena



In March I started a post-doc within the RESINEE project (Resilience and interaction of networks in ecology and economics), in the Department of Innovation and Environmental Science, Faculty of Geosciences, under the supervision of prof. Max Rietkerk. My main interest during this postdoc is to study the coexistence of different vegetation types in water-limited areas, including vegetation-resource feedback mechanisms that may lead to vegetation spatial self-organization. These mechanisms also influence ecosystem resilience to changes, e.g. due to varying climatic conditions.

I got my PhD in Environmental Monitoring, in Savona, with the University of Basilicata (Italy). After my PhD I had a Post-Doc position in Turin at the Italian National Resource Council (CNR), where I was working on the relationship between vegetation and climate. I was particularly interested in modeling vegetation as an active component of the climate system.

Resilience and interaction of networks in ecology and economics (RESINEE)

M. Baudena*

Utrecht University, Utrecht, The Netherlands

RESINEE is a project intended to make connections between issues related to the robustness of networks appearing in economics and ecology. In this talk, we will present the directions we have identified in trying to establish these connections and to allow each field to profit from the other, as well as the main difficulties we face. In particular, we will discuss work in progress about the application of ecosystem stability ideas to economic networks and about the evolution of countries' productive structures to the structure of ecological communities. Time permitting, we will also mention briefly other possible connections.

Prof. Dr. Janusz Hołyst



Professor Dr. Janusz A. Hołyst (*1955) is a Full Professor at Faculty of Physics, Warsaw University of Technology where he leads a Center of Excellence of Complex Systems Research. His current research includes models of emotions in cybercommunities, economic and social networks, collective bankruptcies, collective opinion formation, non-equilibrium statistical physics, cellular automata, self-organized criticality and phase transitions. He is one of the pioneers in applying physical methods to economical and social systems and is the Co-Founder and Chairman of the Section Physics in Economy and Social Sciences of Polish Physical Society. He was a scientific advisor of 7 completed Ph.D. thesis on nonlinear dynamics and complex systems. His list of publications includes over 120 papers (www.if.pw.edu.pl/~jholyst) in peer reviewed journals that have been cited over 800 times.

Prof. Hołyst has organized or co-organized 15 international interdisciplinary workshops or conferences on complex systems. He acts as an Associate Editor of *European Journal of Physics B*, Guest Editor of *Physica A*, *Acta Physica Polonica*, *Acta Physica Polonica B* and as a referee many other physical journals. Prof. Hołyst maintains a close collaboration with many Institutes in Germany, France, and Italy, where he spent over six years as Guest Scientist, Visiting Professor or a fellow of Humboldt Foundation. He has been a coordinator or a partner of several European Union Projects, ICT Project *Collective Emotions in Cyberspace (Cyberemotions)*, NEST Project *Critical Events in Evolving Networks (GREEN)*, NEST Project *Measuring and Modelling of Complex Networks Across Domains (MMCOMNET)*, COST P10 Action *Physics of Risk* and COST Action MP0801 *Physics of Competition and Conflicts*. Hołyst is a Co-Founder and the President of Polish Council for Research Projects Coordinators.

Prof. Hołyst has worked as an adviser on modelling of marketing and economic processes for American Company *Bunge*.

Daniela Paolotti



Daniela Paolotti completed her undergraduate studies at the Department of Physics of the University of Perugia (Italy) in February 2001, with a thesis on "Transport phenomena in granular media". After that she received a scholarship at the University of Michigan in Ann Arbor (USA). In 2005 she received her PhD in Physics from the University of Camerino (Italy) with a thesis on "Driven Granular Media: a Numerical Approach". Right after she was hired in the Computational and Modeling Unit at the Casaccia Research Center of ENEA (Italian National Agency for New Technologies, Energy and the Environment). At the same time she began working on the ENEA Grid Project at the ENEA Frascati Research Center. In 2006 she joined the Bioinformatics unit of the Novartis V&D Research Center in Siena (Italy), as a biostatistician in the MenB project. Since November 2007 she has been working as a Research Scientist at the Complex Networks Lagrange Laboratory (CNLL) of the ISI Foundation (Torino, Italy). Her research focuses on the simulation and modeling of the spreading of infectious diseases, and on the development of Internet-based monitoring systems.