

Newsletter of the FoCAS Coordination Action

FUNDAMENTALS OF COLLECTIVE ADAPTIVE SYSTEMS

FoCAS

ISSUE SEVEN : AUTUMN 2015

SASO UBIComp ICT
project articles news
publications reports
and much more...

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Editorial

Welcome.

Issue seven of the FoCAS newsletter contains details on three forthcoming events that FoCAS are involved with; SASO 2015 where we've joined with SCOPES to run our 3rd Workshop on Fundamentals of Collective Adaptive Systems; meanwhile FoCAS International Collaboration partner Alois Ferscha is running a Workshop at UBICOMP 2015 in Osaka, Japan on "Collective Adaptation in Very Large Ubicomp" and lastly at ICT2015 in Lisbon we're running a networking session called "Perspectives on Collectives".

Inside you'll also find an article by the Swarm Organ project titled "Gene regulatory networks creating patterns in a Kilobot swarm" and one by Allow Ensembles called "Collective Adaptation in Smart Cities". Allow Ensembles also report on their 2014 Workshop - "Business Processes in Collective Adaptive Systems".

This issue also reports on ECAL 2015 where FoCAS ran an illuminating and thought-provoking workshop alongside ERIE on "Steering Complex Adaptive Systems & Fundamentals of Collective Adaptive Systems" and we report on a FoCAS-related workshop at ICAC 2015 where Giacomo Cabri (FoCAS), Jeremy Pitt (FoCAS) and Antonio Bucchiarone (Allow Ensembles) were all present.

Furthermore, the FoCAS project Diversify reports on "Diversity Engineering" and detail their ICT session on "Browser Fingerprinting", and we have an overview of the recently adopted project subCULTron: Submarine Cultures Perform Long-Term Robotic Exploration Of Unconventional Environmental Niches - with details on their forthcoming event at EXPO 2015 in Venice, as well as a blog post by Swarm Organ on an educational robot, news from ASSISI_bf on their Fish-Casu's, and a snippet on Smart Society's Science Cafe video series.

Finally, there are updated details of project publications and a number of FoCAS-related future events.

Our website at www.focas.eu houses an ever-growing suite of useful resources (over 80 video interviews) and our FoCAS membership now stands close to three hundred and fifty researchers who receive regular e-bulletins. If you're not already a member, see opposite on how to get involved.

Best wishes,

The FoCAS Initiative

Get Involved!

PLEASE TAKE OUR THREE MINUTE SURVEY

Contribute to future research in this area:
www.focas.eu/three-minute-survey/

or, SUBMIT A RESEARCH CHALLENGE

www.focas.eu/research-landscape/challenges

JOIN THE FoCAS COMMUNITY

That way you can keep informed about our research via occasional e-bulletins:
www.focas.eu/join-focas

FoCAS READING ROOM

The FoCAS Reading Room provides online access to a series of specially-commissioned feature articles on all aspects of collective adaptive systems, and links to relevant news-feeds and articles from other publications. As a collective adaptive system itself, there are opportunities for the community to get involved, either by nominating prospective authors for feature articles, or by contributing a features article.

Please contact the the FoCAS editor:
Jeremy Pitt
(j.pitt@imperial.ac.uk).

www.focas-reading-room.eu

FoCAS TWEETS

We like to use Twitter to communicate our work and that of our partners and associated individuals and organisations.

Follow us: @FETFoCAS | #FETFoCAS

FoCAS/SCOPES 3rd Workshop on Fundamentals of Collective Adaptive Systems at SASO 2015

www.focas.eu/saso-2015/programme.html

ICT 2015

FoCAS session:
Perspectives on Collectives

www.focas.eu/ict-2015

Tuesday 20 October: 16:50-17:35

Workshop on Collective Adaptation in Very Large Scale Ubicomp: Towards a Superorganism of Wearables at UBICOMP 2015 in 7th September, Osaka, Japan: www.focas.eu/towards-superorganism-wearables

Download the FoCAS App - The textbook of the future

iOS: <http://itunes.com/apps/Focas>

Android: <https://play.google.com/store/apps/details?id=eu.focas.focasapp>

FoCAS @SASO 2015

The 2015 edition of the Self-Adaptive and Self-Organising Systems (SASO) conference series will be held in Cambridge, Massachusetts, and hosted by MIT during the week of 21-25 September. SASO is part of FAS* (Foundation and Applications of Self* Computing Conferences), and is co-located with the International Conference on Cloud and Autonomic Computing (CAC 2015) and the 15th IEEE Peer-to-Peer Computing Conference.

FoCAS is running a **workshop** at SASO in conjunction with SCOPES, Spatial and Collective PErvasive Computing Systems. It will be run on **Monday 21 September**, and is the third peer-reviewed workshop on Fundamentals of Collective Adaptive Systems. A **Science Café** open to all SASO participants will take place from 4pm to present some main findings for the FoCAS research roadmap outlining how and where CAS research will develop in future, and this open discussion session will offer the audience a chance to shape the final FoCAS report being delivered to the European Commission.

The workshop organisers from FoCAS and SCOPES are:

Giacomo Cabri
(Università di Modena e Reggio Emilia, Italy and FoCAS Research Agenda leader)

Nicola Capodiecì
(Università di Modena e Reggio Emilia, Italy)

Mirko Viroli (Università di Bologna, Italy)

Jacob Beal
(Raytheon BBN Technologies, Cambridge, Massachusetts, USA)

Jane Hillston
(University of Edinburgh, UK and QUANTICOL

Three sessions will present nine papers:

Session 1: Organizations

Rule Conflicts in Holonic Institutions

Jie Jiang, Jeremy Pitt and Ada Diaconescu

An Approach for Collective Adaptation in Socio-Technical Systems

Antonio Bucchiarone, Naranker Dulay, Anna Lavygina, Annapaola Marconi, Heorhi Raik and Alessandra Russo

Session 2: Foundations

Toward Predicting Distributed Systems Dynamics

Amy Kumar, Jacob Beal, Soura Dasgupta, Raghu Mudumbai

Analyzing Resilience Properties of Different Topologies of Collective Adaptive Systems

Thomas Glazier, Javier Camara, Bradley Schmerl and David Garlan

A logic language for run time assessment of spatial properties in self-organizing systems

Francesco Luca De Angelis and Giovanna Di Marzo Serugendo

Recoverable DTN Routing based on a Relay of Cyclic Message-Ferries on a MSQ Network - Yukio Hayashi

Session 3: Applications

Advanced Manufacturing as an Industrial Application for Collective Adaptive Systems

David Sanderson, Nikolas Antzoulatos, Jack Chaplin, Dídac Busquets, Jeremy Pitt, Carl German, Alan Norbury, Emma Kelly and Svetan Ratchev

Exploring Spatio-temporal Properties of Bike-sharing Systems

Vincenzo Ciancia, Diego Latella, Mieke Massink and Rytis Paskauskas

Computational Fields meet Augmented Reality: Perspectives and Challenges

Danilo Pianini, Angelo Croatti, Alessandro Ricci and Mirko Viroli

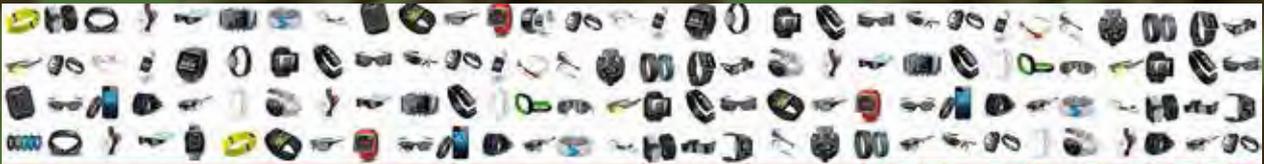
FoCAS is also sponsoring two travel bursaries for the SASO Doctoral Symposium taking place over 22-23 September which aims to provide mentoring support and feedback to PhD students working in FAS areas. This year's participants come from Austria, Ireland, Germany, Norway, USA and India.

Doctoral Symposium organizer **Antonio Bucchiarone** (member of the ALLOW ENSEMBLES project) has arranged several showcasing opportunities for the selected PhD participants including full presentation during the symposium session on 22 Sept as well as lighting talks and a poster session on 23 Sept during the main conference. The two recipients of the FoCAS travel bursaries adjudicated by **Antonio Bucchiarone** and **Evert Haasdijk**, FoCAS Training Activities Leader are :

Ognjen Scekcic, a research assistant at the Distributed Systems Group, TU Wien, Austria, where his PhD is looking at socio-technical Collaborative Adaptive Systems in the context of the SMART SOCIETY research project. His paper "Incentive Mechanisms for Social Computing" focuses on incentive management and programming models for hybrid CAS. Ognjen has also been invited to give a talk at the IBM T J Watson research centre in New York.

"Testing Self-Organizing, Adaptive Systems" is the title of the presentation from **Benedikt Eberhardinger** from Augsburg University, Germany who argues that testing is an essential part of engineering self-organizing, adaptive systems, made difficult due to the every-changing environment.

Jeremy Pitt from Imperial College London who leads the public dissemination work in FoCAS will present the keynote talk at the SASO Doctoral Symposium : "Now you've got a PhD in Self-* Systems, let's look at the future...!"



COLLECTIVE ADAPTATION IN VERY LARGE SCALE **UBICOMP**

Workshop on: Collective Adaptation in Very Large Scale UbiComp: Towards a Superorganism of Wearables

Taking place at UBIComp 2015 on 7 September 2015 in Osaka, Japan

This second workshop edition considers the potential and opportunities for turning massively deployed wearable systems into a globe-spanning superorganism of socially interactive personal digital assistants. While individual wearables are of heterogeneous provenance and typically act autonomously, it stands to reason that they can (and will) self-organize into large scale cooperative collectives, with humans being mostly out-of-the-loop. A common objective or central controller may thereby not be assumed, but rather volatile network topologies, co-dependence and internal competition, non-linear and non-continuous dynamics, and sub-ideal, failure-prone operation. We refer to these emerging massive collectives of wearables as a “superorganism” since they exhibit properties of a living organism such as collective intelligence. In order to properly exploit such superorganisms, this workshop concerns itself with the development of a deeper scientific understanding of the foundational principles by which they operate, thereby addressing:

- Understanding of trade-offs between the power of top-down (by design) adaptation means and bottom-up (by emergence) ones, also by studying how the two approaches co-exist in modern wearable ICT systems, and possibly contributing to smoothing the tension between the two approaches.
- Understanding the “power of the masses” principle as far as participatory wearable ICT processes are involved. In particular, this implies understanding how and to what extent even very simple collective phenomena and algorithms - when involving billions of wearables - can express forms of intelligence much superior than that of more traditional AI techniques.
- Understanding the issue of diversity and of diversity increase in complex systems and in service/data systems and how diversity of structure and behaviour is currently accommodated in wearable ICT systems. As of now, most studies focus on a limited number of different classes, which is far from approximating the diversity of existing systems.
- Laying down new foundations for the modelling of large-scale Human-ICT organisms and their adaptive behaviours, also including lessons from applied psychology, sociology, and social anthropology, other than from systemic biology, ecology and complexity science.
- Identifying models and tools by which individual organs of the systems can influence and direct “by design” the emergent adaptive behaviour of the whole system, or at least of substantial parts of it

This workshop is held at the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2015) which co-located with the 19th International Symposium on Wearable Computers (ISWC). Workshop organisers are

Alois Ferscha (University of Linz, Austria)

Paul Lukowicz (DFKI, Germany)

Franco Zambonelli (Universita di Modena e Reggio Emilia, Italy)

More information at <http://focas.eu/towards-superorganism-wearables>

The UBICOMP workshop preliminary programme includes:

- **Keynote:** “What if you know it all? Quantifying human behaviour from a virtual world” by **Stefan Thurner**, Medical University of Vienna, Austria
- **Keynote:** ”Programming Very-large Scale Systems of Wearables” by **Mirko Viroli**, Università di Bologna, Italy
- **Invited Talk :**”Collective Eyewear” by **Kai Kunze**, Keio University, Japan
- **Invited Talk :** “Contact-free Sensing for Collective Activity Recognition” by **Stephan Sigg**, University Goettingen, Germany

Technology - are we there yet?

Position Statements by Participants (10 mins, 4 slides each)

Understanding, Modelling, Inducing Collective Behaviour

Position Statements by Participants (10 mins, 4 slides each)

Short Talk “CAS Research Agenda” by **Alois Ferscha**, Johannes Kepler University Linz, Austria

Open Discussion

ICT 2015

Innovate, Connect, Transform is the name of the European Commission’s ICT 2015 conference being held in Lisbon Portugal on 20-22 October to cover the intertwining themes of innovation and creativity while connecting people and the digital society to transform business and industry. The event will comprise a number of parallel activities including a **conference** presenting EC policies and innovation within Horizon 2020; the ICT **exhibition** showcasing 150 exhibitors presenting the best of ICT research and innovation; also 130 **networking sessions** targeting themes and challenges relevant to Horizon 2020 and as well as Face2Face meetings, networking booths and “cosy corners”; and the **Startup Europe Forum** to motivate an entrepreneurial environment. **Registration to ICT 2015 is free** and more information is available at <http://ec.europa.eu/digital-agenda/en/ict2015-innovate-connect-transform-lisbon-20-22-october-2015>

FoCAS will run a networking session entitled **Perspectives on Collectives** at the ICT 2015 on **Tuesday 20 October at 16:50-17:35** in room 13 of the Centro de Congressos de Lisboa. The main objective to air a range of views on the perceived benefits and risks from collective adaptive systems. Two scenarios will be presented from FoCAS projects, research-informed scenarios that provide examples of adaptation to unforeseen situations and the possibility of unexpected outcomes, both positive and negative. Audience discussion and voting is an integral part of this session.
www.focas.eu/ict-2015



The DIVERSIFY project will also demonstrate how software diversity can be exploited to improve privacy protection on the web within the INNOVATE section of the ICT exhibition.

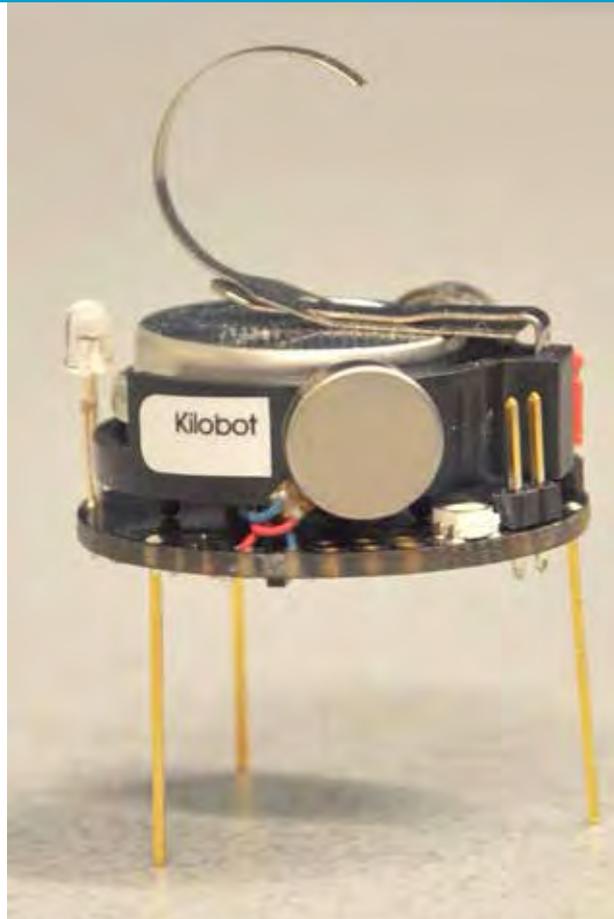
Gene regulatory networks creating patterns in a Kilobot swarm

Jorren Bosga, Fredrik Jansson

(F.R.Jansson@uva.nl)

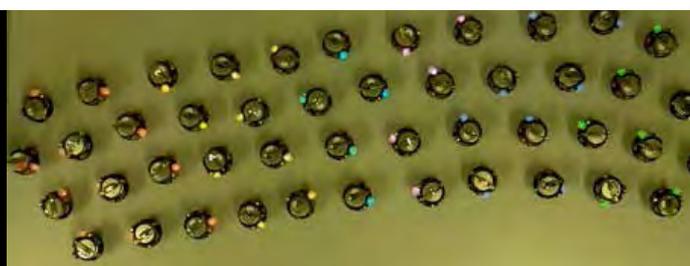
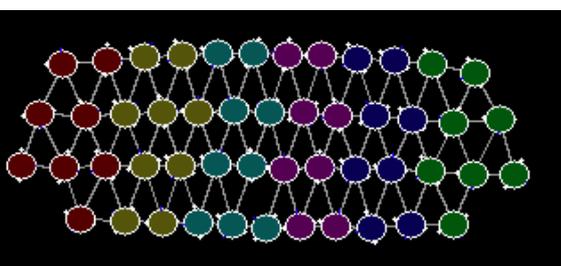
Swarm Organ Project www.swarm-organ.eu

As our ability to develop complex artificial systems improves, inspiration is sought in perhaps the most perfect example of complexity: nature. Especially in the new field of swarm robotics, which aims to develop large groups of robots displaying collective behavior, nature is used as a source of inspiration. In the Swarm Organ project, we explore using the biological principles of gene regulation to control a swarm of robots, where the robots communicate only with their close neighbors. As one example, we are using the genetic make-up of the common fruit fly, *Drosophila melanogaster*, as a means to achieve patterning or differentiation of agent functions in the robot swarm. The fruit fly is among the most well-documented organisms in biology. During its embryonic stage, a number of genes, known as the gap genes, are expressed along its body in a stripe-like pattern.



This pattern is later refined, and serves to define the segments of the fruit fly body and to determine the function of each segment. The gap gene stripe pattern consists of four genes, and is formed by interactions among the genes facilitated by proteins, or morphogens. These morphogens are produced by the genes, and can activate or repress other genes. The resulting network of interactions is called a gene regulatory network, and is often at the basis of complex pattern formation in biology.

A gene regulatory network inspired by that of the fruit fly gap genes has been implemented in a swarm of Kilobots. The Kilobots are small, cheap and simple robots developed by the Self-Organizing Systems research group at Harvard University. We use these robots in the Swarm-Organ project to try out our swarm control algorithms in practice. The robots possess a number of simple functions that allow them to interact with each other and, under the right control system, operate as a swarm: the Kilobots can move using vibration motors, display their internal state with a tricolor LED, and communicate with their neighbors using infrared light. Using these robots, our fruit-fly inspired network produces a striped distribution of 'genes', or states. The starting state is a gene distribution with two genes forming opposing concentration gradients along the longer axis of the swarm. In both simulated and real Kilobot swarms, striped patterns containing up to four additional genes were created based on these gradients.

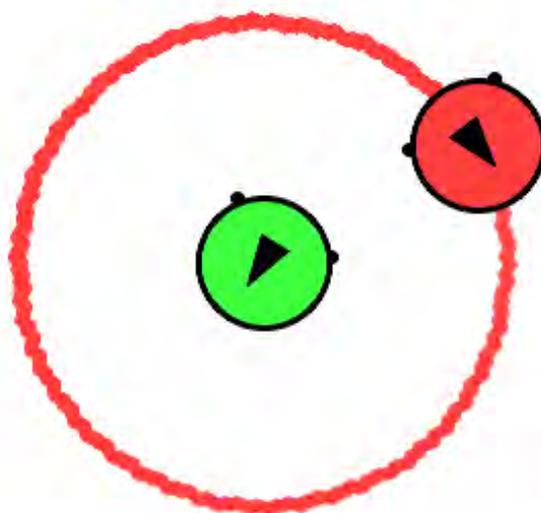


From this pattern, different tasks could be distributed among different groups of robots, similar to the way some cells become skin cells, and others become muscle cells. These findings signify a small yet promising step in recreating biological processes with artificial systems.

Kilobot Simulator

The Kilobot was selected for use in the Swarm Organ project, partially because its lower unit cost compared to other research robots makes larger swarms feasible. The Kilobot robot is based on an ATmega 328 microcontroller, which is programmable in C. When developing programs for the Kilobots, it is convenient to be able to test the program in a simulator running on a desktop computer. As no simulator was available which can run the same program as the real Kilobots, we decided to create our own. When the simulator is running the same program, from the same source code file as the real robots, it is possible to test not just the algorithms in principle, but also the actual implementation of them. It also means only one version of the Kilobot program needs to be written and maintained, instead of separate versions for the simulator and the real robot.

The simulator will be released in the near future under an open source license. We already use it routinely within the project for Kilobot program development.



Simulated and real Kilobots performing an Orbit demonstration, where one robot moves around another stationary one, while keeping a constant distance to it.

Related upcoming events

SENSORNETS 2016: 5th International Conference on Sensor Networks - 19-21 Feb, Rome, Italy

CASSTING 2016: Workshop on Games for the Synthesis of Complex Systems @ ETAPS 2016 2-8 April 2016, Eindhoven, The Netherlands

AAMAS 2016: International Conference on Autonomous Agents and Multi-Agent Systems - 9-13 May 2016, Singapore

ICAC 2016: 18th International Conference on Autonomic Computing - 19-20 October 2016, Dubai, UAE

Collective Adaptation in Smart Cities

Antonio Bucchiarone, Annapaola Marconi, Naranker Dulay, Anna Lavygina and Alessandra Russo
 ALLOW ENSEMBLES www.allow-ensembles.eu

The Internet of Services (IoS) foresees a future Internet in which the provisioning of, access to and use of services will be as widespread as content is today. Smart Cities are becoming one of the main drivers in the eruption of this wave. The urgent need for a more efficient and sustainable society, together with the spread of ubiquitous communication networks, highly distributed wireless sensor technology, and intelligent management systems, makes the Smart City ecosystem an ideal ground for IoS.

In this setting, the role of service-oriented computing is to enable the integration and interplay between new and legacy city services to solve current and future challenges and support the creation and delivery of innovative and efficient services for the citizens.

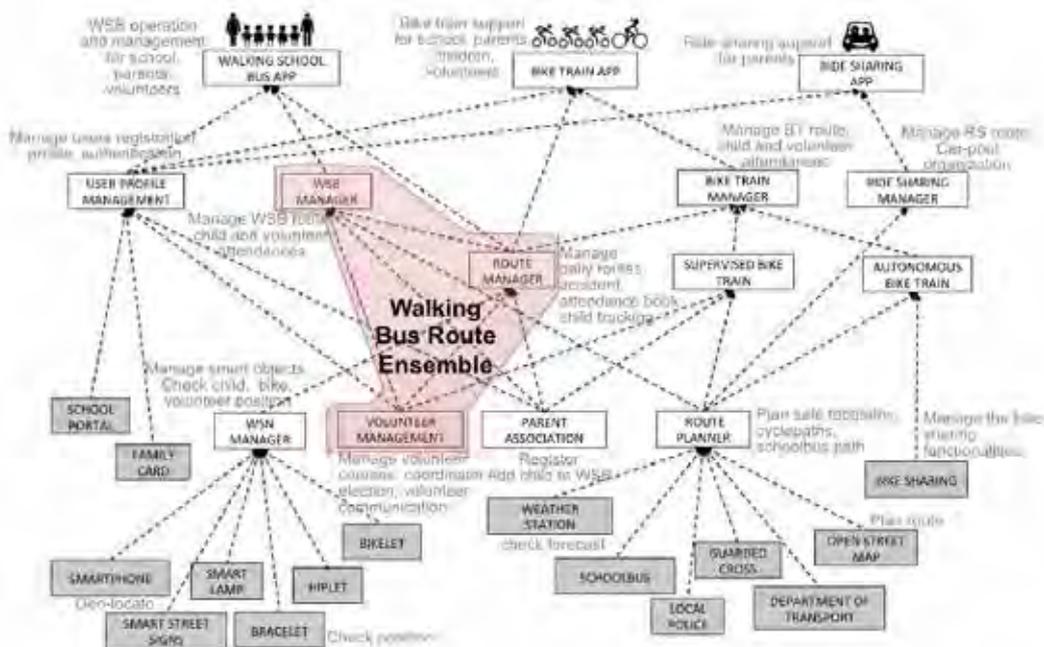


Figure 1: A partial overview of the smart children mobility system.

A key challenge that still needs to be overcome for this to become a reality, is the capability of dealing with the continuously changing and complex environment in which Smart City applications operate. Consider for instance the case of a smart children's mobility system (depicted in Figure 1), supporting service users (parents, children) and providers (drivers, teachers, traffic aids, volunteers) in their daily operation and management of children mobility services (e.g., school buses, walking buses, bike trains, ride-sharing among parents).

If the aim is to deliver smart children mobility services to citizens, all the entities involved cannot be operated each by itself, but should become part of an integrated mobility solution, the Smart Children Mobility System (SCMS), that supports users (parents, children) and providers (teachers, drivers, traffic aids and volunteers) in their daily operation and management of the different mobility services.

Even though these entities are generally autonomous, they dynamically form collaborative groups, called ensembles, to gain benefits that otherwise would not be possible. The example of such an ensemble is a Walking Bus Route (WBR) (see Figure 1) which coordinates the adaptation behavior of multiple entities (WSB Manager, Route Manager and Volunteer Management) and in return gives them certain benefits (e.g., safe and dynamic handling of children walking bus routes). Membership of an ensemble may temporarily reduce the flexibility of its entities. Within this context, isolated entity self-adaptation is not effective. We can easily imagine what happens if a volunteer assigned to a specific WBR and then silently changes her mind and decides not to travel. It is likely to cause the route cancellation if notified in delay. Even more serious consequences arise if the weather conditions deteriorate and the WSB manager decides to suspend the

Walking School Bus. In such a systems new approach for adaptation are therefore needed that allow (i) multiple entities to collectively adapt with (ii) negotiations to decide which collective changes are best. Collective adaptation also raises a second important challenge: which parts of the ensemble should be engaged in an adaptation? This is not trivial at all, since solution for the same problem may be generated at different levels. For instance, the volunteer cancellation can be resolved in the scope of the WBR (same ensemble), by finding a substitute, or in a wider scope finding an alternative way of bringing children to school (i.e., assign them to another walking bus, use school bus or RideSharing initiatives, etc..). The challenge here is to understand these levels and create mechanisms to decide the right scope for an adaptation for a given problem.

In ALLOW Ensembles project, we are realizing a novel approach for collective adaptation that is driven by awareness of the capabilities, goals, constraints and preferences of humans and entities, as well as the knowledge of the environment. Our adaptation process is distributed and is controlled by a multi-criteria decision making function that is combined with an analytic hierarchic process (AHP) to select best adaptation alternatives.

The above description is an excerpt from a recent publication by Antonio Bucchiarone, Annapaola Marconi, Naranker Dulay, Anna Lavygina and Alessandra Russo.

International Workshop on Business Processes in Collective Adaptive Systems (BPCAS 2014)

To promote topics related to FoCAS, ALLOW Ensembles consortium organized the International Workshop on Business Processes in Collective Adaptive Systems (BPCAS 2014) that took place in conjunction with the 12th International conference on Business Process Management (BPM) at Eindhoven University of Technology, Eindhoven, Netherlands in September 2014. The BPM conference is the leading forum in the field of business process management.



Participants at the International Workshop on Business Processes in Collective Adaptive Systems

The workshop program included a keynote talk by **Manfred Reichert**, a leading researcher in BPM community. The talk was titled: "Collective Adaptive Process-Aware Systems: Challenges, Scenarios, Techniques". Moreover, the program included thirty minutes research presentations by the authors of the following three accepted papers.

- **Hong-Linh Truong** and **Schahram Dustdar**: Context-aware Programming for Hybrid and Diversity-aware Collective Adaptive Systems.
- **Rama Akkiraju** and **Hamid Motahari**: Towards Cognitive BPM as the next generation BPM platform for analytics-driven business processes.
- **Santiago Gómez Sáez**, **David Richard Schäfer**, **Thomas Bach**, **Vasilios Andrikopoulos** and **Muhammad Adnan Tariq**: Towards Ensuring High Availability in Collective Adaptive Systems.

The workshop was well received by the BPM community: in addition to the presenters, more than 20 participants of the conference visited the workshop and engaged in healthy discussions.

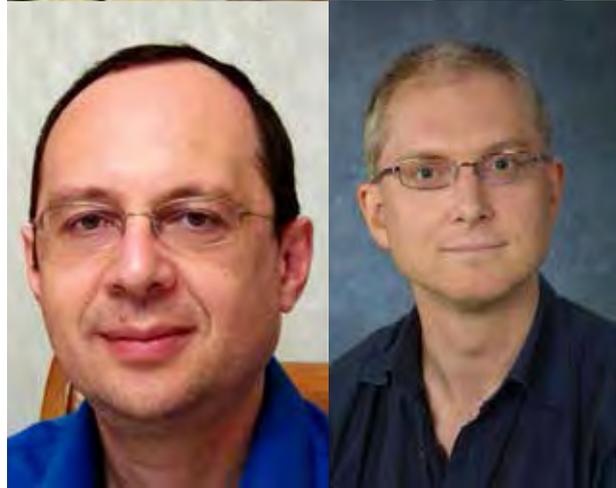
FoCAS @ ICAC 2015

A FoCAS-sponsored Distributed Adaptive Systems workshop was held at the 12th IEEE International Conference on Autonomic Computing (ICAC) in Grenoble, France, on 7 July 2015. Organised by FoCAS research agenda WP leader, **Giacomo Cabri** along with **Antonio Bucchiarone** from the ALLOW Ensemble project, this workshop covered CAS-relevant topics and provided an airing for discussion relevant to FoCAS roadmap activities.

Four papers were presented (acceptance rate was) to an audience of around 20.

- **Thomas Preisler, Tim Dethlefs and Wolfgang Renz:** Middleware for Constructing Decentralized Control in Self-Organizing Systems
- **Kaoutar Hafdi and Abdelaziz Kriouile:** Designing ReDy Distributed Systems
- **Jingtao Sun and Ichiro Satoh:** Distributed Adaptation through Software Component Relocation
- **Claudia Raibulet and Andrea Zaccara:** Adaptive Resource Management in the Cloud

FoCAS also sponsored a keynote ICAC talk by Tarek Abdelzaher on Wednesday 8 July on “The Social Frontier for Autonomic Systems”; an interview to Tarek is available in the video opinion section of the FoCAS website (<http://focas.eu/topic/video-opinions/>). FoCAS executive member **Jeremy Pitt** gave an ICAC invited talk on 9 July, entitled “Governance, Justice and Paradox in Self-Organising Rule-Oriented Systems”.



FoCAS App now available

The Focas App is the textbook of the future: a free, evolving, searchable and accessible collection of curated material about Collective Adaptive Systems at your fingertips:

- What is a CAS?
- Is a colony of bees a CAS?
- Is the internet a CAS?
- How can you build a CAS from a bunch of robots?
- Can a CAS learn? Are they dangerous?
- What can I do with them?



The FoCAS App answers these and many others through a collection of papers, movies, presentations, demonstrations, tutorials and references.

Whether you're a student looking for a definition, a researcher trying to widen your understanding of CAS research or just want to know a bit more about CASs, the material in the app will help you find out what you need.

This app allows you to have material ranging from introductory descriptions to cutting edge research papers available any time, anywhere.

iTunes download: <http://itunes.com/apps/Focas>

Google Play download: <https://play.google.com/store/apps/details?id=eu.focas.focasapp>

FoCAS adopt subCULTron project

FoCAS have adopted another project – **subCULTron: Submarine Cultures Perform Long-Term Robotic Exploration Of Unconventional Environmental Niches** (www.subcultron.eu). You can view the project’s abstract below and if you’re Twitter literate follow them here: @subCULTron

subCULTron aims for achieving long-term autonomy in a learning, self-regulating, self-sustaining underwater society/culture of robots in a high-impact application area: Venice, Italy.

Our heterogeneous system consists of three different agent types:

On the sea-ground, artificial mussels are the collective long-term memory of the system, allowing information to stay beyond the runtime of other agents, thus allowing to continue learning from previously learned states. These mussels monitor the natural habitat, including biological agents like algae, bacterial incrustation and fish.

On the water surface, artificial lily pads interface with the human society, delivering energy and information influx from ship traffic or satellite data.

Between those two layers, artificial fish move/monitor/explore the environment and exchange info with the mussels and lily pads. Artificial mussels are novel class of underwater agents.

We aim to push forward the edge of knowledge with novel sensors (electric sense/electro-communication), novel bio-inspired algorithms (underwater hives) and novel energy harvesting in underwater scenarios.

We will improve the world’s record for swarm-size in autonomous collective underwater robotics by almost one order of magnitude.

Our application field is a human- and animal-co-inhabited real-world environment of high impact: Venice canals & lagoon.

These habitats are highly dynamic and structured, expected to be reflected by a spatial self-structuring of our mussel population.

These sub-populations locally perform memetic or cultural learning algorithms on their specific local data. Thus our cultural evolution algorithms will promote sub-culture development, similar to the human society that does the same above the water level in parallel.

Overall, we aim for an artificial society underneath the water-surface to the service of a human society above the water.

Objectives of the project:

Enable emergence and adaptation of the “individual being”, Enable emergence and adaptation of the “collective group being”, Provide minimum-requirement communication of beings, Establishing the “long-term being”, Survival through socialization, Novel bionic perception principles, Increasing public awareness, acceptance & interactions of “smart environments”

Special aspects of the project:

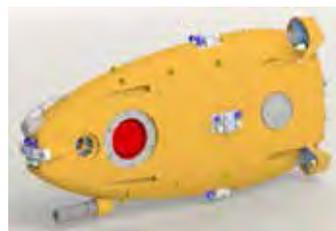
Engineering for long-term persistence, Engineering for heterogeneity, Sensing/Anchoring in turbid and turbulent waters
Social/Cultural/Group: Collective cognition, Long-term learning & adaptation, Stability & Robustness



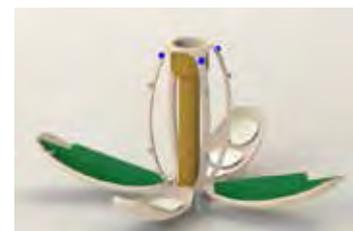
subCULTron



aPads: These agents at the surface will provide global cognition, user interaction and energy autonomy for the whole system.



aFish: These highly manoeuvrable agents will provide action and information transfer.



aMussels: These very weakly actuated units will provide long-term spatial coverage.

FoCAS Report from ECAL 2015

ECAL 2015 was the 13th European Conference on Artificial Life (ECAL 2015) held in York, UK, from 20-24 July 2015, hosted by the York Centre for Complex Systems Analysis at The University of York. The FoCAS Coordination Action joined forces with researchers from the complex systems community to run a workshop entitled Steering Complex Systems which presented a series of themed short invited talks with structured discussion.

Organised by **Alexandra Penn** (University of Surrey), **James Dyke** (University of Southampton), and **Emma Hart** (Edinburgh Napier University), the workshop was held on 20 July and considered the engineering challenges relevant to complex and collective adaptive systems. Conventional approaches to working with CAS are, for the most part, “brute force”, attempting to effect control in an input and effort intensive manner and are often insufficient when dealing with their inherent non-linearity and complexity. Such systems by their very nature are dynamic, adaptive and resilient and require management tools that interact with dynamic processes rather than inert artefacts. “Steering” in which we continuously interact with systems, is one way by which this might be accomplished, manipulating them or their environment via effective leverage points which exploit their structure and dynamics; monitoring their response and responding to their adaptation. However, the plethora of tools and techniques plus the overarching methodological framework required for this approach is at a nascent stage.

This was a broad-ranging and discursive workshop aiming to identify key ideas within, and the implications for, new paradigms. Guest speakers included:

Setting the Scene: Overarching questions

Sarah Cornell, Stockholm Resilience Institute - *Sustainability challenges in a complex world*

Vivek Nallur, Trinity College Dublin - *Where shall we have lunch? Problems for a computer-aided future*

Examples and Tools: Technological and Bio-hybrid Systems

Thomas Gabor, Ludwig-Maximilians-Universitat Munchen - *The Liquid Computing Paradigm*

Rob Mills, BioISI, Univ Lisboa

On manipulating attractors in collective behaviours of bio-hybrid societies with robot interactions

New Approaches: Sociological and philosophical perspectives on managing living systems

Anna Krzywoszynska, University of Durham

Uncertainty, intuition and care in the management of vineyards and wine fermentations

Simon McGregor, University of Sussex

Wrangling Complex Systems – A Near-Life Perspective On Complex Systems Control



Project snippets

Swarm Organ blog post: AERobot: an Affordable Education Robot 9 Jul 2015

AERobot (Affordable Education Robot) is a highly modified version of the Kilobot robot, re-designed specifically as a low-cost (\$10.70 including assembly) education robot. It is designed to introduce students of all ages to the fundamentals of programming and control of robots, with the hope of inspiring them to further pursue studies in Science, Technology, Engineering and Math.

This robot has been created by the same group of Harvard University led by **Dr. Radhika Nagpal** that created the kilobots used in our project. Nevertheless, modifications include the removal of swarm capabilities of Kilobot, the addition of more sensors, and simplifying its charging and programming. It is cheaper than the kilobot in parts, and have some interesting features, such as turn in place, by giving the option to run motors in both directions, optical distance sensing to obstacles (in 3 directions), line following with two sensors under the robot and programming via USB port on the robot PCB.

AERobot's low cost (\$10.70 including assembly) will enable more students, especially those who could not normally afford to do so, to gain hands-on experience in robotics. The hardware is open-source, making it possible for each student to have (and keep) their own robot, while still encompassing a rich sensor suite enabling a variety of activities. A free, open-source graphical programming environment allows students without previous programming experience to command the robot. In addition to robot design, they have created a software suite for the robot by modifying minibloqs, a graphical programming language, and created a 15 lesson curriculum for a student with no starting experience to learn the basics of programming flow and logic, the use of sensors and actuators, and to create robot behaviors.

More information in: <https://sites.google.com/site/affordableeducationrobot/home/hardware>



Photo of AERobot (Affordable Education Robot)

Smart Society Science Cafe

Smart Society have produced a number of video interviews hosted by **Daniele Miorandi** (Create-Net) and featuring **Vincenzo Maltese** (University of Trento), **Luc Moreau** (University of Southampton) and **Michael Rovatsos** (University of Edinburgh). You can view the videos here: www.smart-society-project.eu/category/video



DIVERSIFY - www.diversify-project.eu

A survey about software diversity will appear in the ACM Communications Survey.

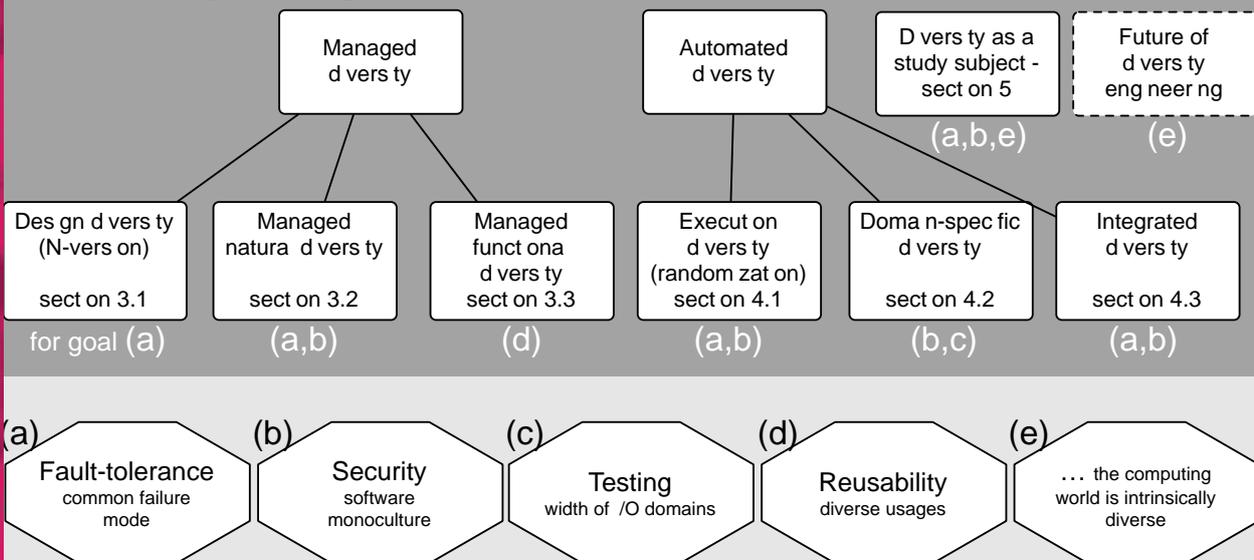
Early experiments with software diversity in the mid 1970's investigated N-version programming and recovery blocks to increase the reliability of embedded systems. Four decades later, the literature about software diversity has expanded in multiple directions: goals (fault-tolerance, security, software engineering); means (managed or automated diversity) and analytical studies (quantification of diversity and its impact).

Our paper contributes to the field of software diversity as the first paper that adopts an inclusive vision of the area, with an emphasis on the most recent advances in the field, from 2000 to present.

This survey includes classical work about design and data diversity for fault tolerance, as well as the cybersecurity literature that investigates randomization at different system levels. It broadens this standard scope of diversity, to include the study and exploitation of natural diversity and the management of diverse software products.

The targeted audience is researchers and practitioners in one of the surveyed fields, who miss the big picture of software diversity. Assembling the multiple facets of this fascinating topic sheds a new light on the field.

Diversity engineering



Diversity goals

DIVERSIFY @ ICT 2015 in Lisbon

The project will demonstrate how software diversity can be exploited to improve privacy protection on the web: the proactive diversification of software platforms prevents tracking users through browser fingerprinting (a growing practice among web companies to track users without cookies).

Visitors who bring their own device (smartphone, tablet, laptop, etc.) will get an immediate view on the fingerprint of their device and explanations on the features that make their fingerprint unique and on how it can be modified to limit tracking.

Check your browser finger print here: <https://amiunique.org>

View Diversify project presentation on YouTube: <http://youtu.be/YGL5YxO10zs>

subCULTron at EXPO2015 in Venice

The Project subCULTron is proud to announce its contribution to the EXPO 2015 in Venice! From the 12th of October to the 16th of October we will present our project in the EXPO-Venue in Venice (<http://www.aquae2015.org>). We will present live-experiments with the major focus on “underwater-swarm-robotics”, but also with the general topics “Collaboration of Scientists in Venice”, “Protecting the Laguna” and “Interacting Robots - Robotic Cultures”. Our partners from across Europe will perform a robotic workshop directly in the EXPO during the whole week, which will allow visitors to interact with the robots, talk to the scientists, discuss topics like advantages of swarm-robotics and autonomous underwater robotics, discuss issues of environmental protection by self-organising groups of robots (with special focus on the Laguna of Venice), and learn how international scientific consortia in Europe cooperate to serve science and society. Embedded in the impressive EXPO exhibition we are looking forward to intensive discussions with all kinds of audience, beginning with school classes, over businessmen, scientists from international scientific entities present in the northern Adriatic area up to policy makers from all over the world. This is a great opportunity for subCULTron to present the idea of foundational research in robotics to a broad audience. We would be especially glad to welcome colleagues from the FoCAS Initiative to discuss novel ideas, and intensify (even more) the interaction between the members of the FoCAS Initiative.

ASSISlbf - Fish-CASU

In the ASSISlbf project (Animal and robot Societies Self-organize and Integrate by Social Interaction bees and fish), we have designed miniature wheeled robots able to move small lures inside an aquarium through magnetic coupling [1]. The length of the robot is 43 mm, the width 22 mm and the height 67 mm. Very compact, the robot does not need batteries, getting continuous power supply by brushes used to retrieve the power from conductive plates above and under the robot. This allows to run long time experiments with multiple robots. Finally, it is also equipped with infrared proximity sensors to provide obstacle avoidance. Obstacles can be the border of the experimental setup as well as other robots moving during the same experiment.



Figure 1: Fish-CASUs (Control Actuator Sensor Unit), the mobile robots designed for the project ASSISlbf to study the collective behavior of fish.



Figure 2: Two Fish-CASUs coupled with fishing lures that interact with five wild type zebrafish *Danio Rerio*. The two robots can move autonomously in random walk mode avoiding the obstacles with their infrared sensors, or be controlled using a high-level software that track the pose of the lures using a camera on top of the aquarium.

Preliminary experiments have shown that the robots operations do not disturb the fish. The lure being independent from the robot, it can be easily adapted to the various experiments.

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Recent project publications



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florarobotica

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Adaptive Swarm Robot Region Coverage Using Gene Regulatory Networks
Hyondong Oh, Yaochu Jin, Advances in Autonomous Robotics Systems. Lecture Notes in Computer Science. Volume 8717, 2014, pp 197-208, 15th Annual Conference, TAROS 2014, Birmingham, UK. September 1-3, 2014. Proceedings

This book is about understanding, designing, controlling, and governing adaptive collective systems. It is intended for readers from master's students to Ph.D. students, from engineers to decision makers, and anyone else who is interested in understanding how technologies are changing the way we think and live.

The authors are academics working in various areas of a new rising field: adaptive collective systems.

Stuart Anderson (*The University of Edinburgh, United Kingdom*)

Nicolas Bredeche (*Université Pierre et Marie Curie, France*)

A.E. Eiben (*VU University Amsterdam, Netherlands*)

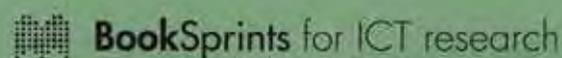
George Kampis (*DFKI, Germany*)

Maarten van Steen (*VU University Amsterdam, Netherlands*)

Book Sprint collaborative writing session facilitator: Adam Hyde

Editor: Sandra Sarala

Designer: Henrik van Leeuwen



Download or read online at:

www.focas.eu/adaptive-collective-systems

Adaptive Collective Systems

Herding black sheep



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FoCAS coordinates the research of 12 research projects, but anyone or group can join if they have a research interest in Collective Adaptive Systems:

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Agent and Pervasive Computing Group

(University of Modena & Reggio Emilia, Italy)

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Institute for Pervasive Computing

(JKU, Linz, Austria)

The socio-technical fabric of our society more and more depends on systems that are constructed as a collective of heterogeneous components and that are tightly entangled with humans and social structures. Their components increasingly need to be able to evolve, collaborate and function as a part of an artificial society.

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