Newsletter of the
FoCAS Co-ordination Action Initiative

www.focas.eu
@FETFoCAS

FUNDAMENTALS OF COLLECTIVE ADAPTIVE SYSTEMS

FOCAS

ISSUE 2: WINTER 2014

NEW FOCAS BOOK!
PROJECTS NEWS
UPCOMING EVENTS, CFP's,
CASE STUDY, READING
ROOM, BOOKSPRINT
SUMMER SCHOOL 2014
SURVEYS, EVENT
REPORTS, RESEARCH
LANDSCAPE

ALLOW ENSEMBLES
ASCENS
ASSISI | bf
CASSTING
DIVERSIFY
ORGANIC COMPUTING
QUANTICOL
SMART SOCIETY
SWARM ORGAN

FoCAS is a Future and Emerging Technologies Proactive Initiative funded by the European Commission under FP7

Image Courtesy of Henrik van Leeuwen

Editorial

Happy New Year!

This newsletter finds us rapidy approaching the end of the first year of the FoCAS proactive initiative. Inside we keep you informed of the many activities the coordination team and our partners have been engaged with over the past six months. We highlight many things that are already in place to support your research and draw your attention to forthcoming activities as well - some of which you are invited to contribute to.

Our website at www.focas.eu has useful resources such as video interviews, research challenges, events details, paper reviews, infographics, slide presentations, project publications, detailed contact information and an up-to-date news stream. Content is always being added so please keep visiting www.focas.eu.

We currently have a membership of over 300 researchers, who recieve regular e-bulletins. If you're not already a member you can 'join us' via our website, alternatively join our Research Gate Group. We'd also appreaciate your particpation in completing our three minute survey, and/or submitting a research challenge. See opposite for how to get involved.

Our FoCAS Reading Room with articles relevant to CAS will be online soon. More info opposite.

We've also expanded! The Organic Computing Initiative and ASCENS Project are now supported under the FoCAS umbrella too, you'll find their contact details inside. If your research project is relevant to FoCAS, why not join us too!

Gusz Eiben shares his Booksprint experience and you can find out where to download/order a copy of the resultant book: Adaptive Collective Systems - Herding Black Sheep.

You can also read reports on our workshop at ECAL 2013 and our session at ICT 2013. There are updates on what the projects have been doing - CFP'S, paper reviews, a case study and featured publications.

Finally, we have dates in June, and a Greek venue for Summer School 2014! See opposite.

For lots more content please visit our website:

www.focas.eu

PARTICIPATE!

TAKE OUR 3 MINUTE SURVEY
Contribute to future research in this area:
www.focas.eu/three-minute-survey/

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

JOIN OUR RESEARCH GATE GROUP
Collective Adaptive Systems:
www.researchgate.net/project/FoCAS

FoCAS READING ROOM COMING SOON!

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, Dr Jeremy Pitt (j.pitt@imperial.ac.uk).

SUMMER SCHOOL 2014

Where: Crete, Greece

When: June 23 - 27

More details to follow at:
www.focas.eu/summer-school-2014

FoCAS is helping to sponsor the Diversify project's workshop in Rennes on 3-4 February 2014 which is considering how graphs can be used to transfer ecological concepts to software design principles. More information here:
www.focas.eu/sponsor-diversify-workshop

FoCAS is sponsoring a best paper award at ALA 2014 (Adaptive and Learning Agents Workshop held at AAMAS 2014 in Paris on 5-6 May. The prize will be a free place at the FoCAS Summer School in Crete on 23-27 June including accommodation and meals. Full details at:
www.focas.eu/best-paper-award-ala-2014

FoCAS sponsor invited speaker at WETICE 2014

FoCAS is sponsoring invited speaker Markus Aleksy from ABB, Germany at the WETICE conference taking place in Parma on 23-25 June who will discuss adaptive mobile and wearable applications:
www.focas.eu/focas-sponsor-invited-speaker-wetice-2014

FoCAS Workshop @ ECAL 2013

FoCAS organised its first workshop at ECAL2013, the 12th European Conference on Artificlal Life on 2 September in Taormina, Sicily. The Fundamentals of Collective Adaptive Systems workshop invited conceptual papers addressing new methodologies, theories and principles relevant to collective adaptive systems. The format of the workshop was designed to promote discussion and authors were asked to submit 2-3 page extended abstracts rather than full papers. Papers were grouped into sessions to stimulate useful discussion:

Adaptation

Continuous Adaptation for Collaborating Adaptive Systems
by Vivek Nallur, Hui Song, Siobhan Clarke

Can Adaptability be Measured ? Yes, it's entropy!
by Rupert Reiger

Discussion: Key aspects of adaptation in FOCAS

Collectives

Morphogenetic Multi-robot Pattern Formation Using Hierarchical Gene Regulatory Networks
by Yaochu Jin and Hyondong Oh

The Sociopsychological Ergonomy of the Collective Awareness Platforms (CAPs)
by Andrea Guazzini

Human-machine coexistence in groups
by George Kampis, Paul Lukowicz and Stuart Anderson

Discussion: Collectives; heterogeneity and conflict

Methodologies and Frameworks

A Unified Framework for Collective Adaptive Systems
by Emma Hart, Jeremy Pitt, Ulle Endriss

Towards Hybrid and Diversity-Aware Collective Adaptive Systems
by Fausto Giunchiglia, Vincenzo Maltese, Stuart Anderson, Daniele Miorandi

A Quantitative Approach to the Design and Analysis of Collective Adaptive Systems
by Rocco De Nicola, Nicolas Gast, Stephen Gilmore, Jane Hillston, Mieke Massink, Mirco Tribastone

Discussion: Pros and cons of frameworks

Giovanna Pacini from the University of Florence gave an invited talk and led discussion on The Science Cafe method for crowdsourcing and public engagement based on her paper with Franco Bagnoli at which participants were invited to text, tweet or write questions relating to FoCAS that were then disused with the audience.

All the presentation slides are available for download at the FoCAS website:

www.focas.eu/workshop-fundamentals-collective-adaptive-systems

FoCAS session at ICT 2013

The FoCAS networking session was held on Thurs 7 Nov at the ICT conference in Vilnius, Lithuania. The topic considered how multi-disciplinary approaches can be advantageous to research, especially when addressing societal challenges. The ICT priority of smart, green and integrated transport was used as an example. The audience of approximately 35 persons represented a range of interests and provided useful comments and feedback. FoCAS project partner **Alois Ferscha**, from the Institute for Pervasive Computing at JKU in Linz chaired the session and the invited panel included: **Linh Truong** from TU Wien, representing the SmartSociety project, **Nikola Serbedzija** from Fraunhofer Fokus Berlin, representing the ASCENS project, **Kim Larsen**, Aalborg University, representing the CASSTING project, **Naranker Dulay**, from Imperial College London, representing ALLOW Ensembles, **Vashti Galpi**, University of Edinburgh representing the QUANTICOL project and **Franco Zambonelli**, member of FoCAS Coordination Action working on the Research Agenda activities who is also Coordinator of the SAPERE project (in the FET Awareness Proactive Initiative).

Research Landscape

www.focas.eu/research-landscape

The FoCAS research landscape aims to provide overview mapping of research topics related to Collective Adaptive Systems. Help us to define the main challenges facing FoCAS research (and suggest your own). Find reviews of relevant research papers and video interviews and you can also:

1. Complete our Three Minute Survey: **www.focas.eu/three-minute-survey**
2. Submit a research challenge: **www.focas.eu/research-landscape/challenges**

The following resources are samples of what is available online at the FoCAS Research Landscape .

Mindmap of CAS methods

More visualisations at: www.focas.eu/research-landscape/visualisation

A selection of background paper reviews

Available at: **www.focas.eu/topic/background-papers**

Flow-Driven Ambient Guidance
Gerd Kortuem, Fahim Kawsar, and Bashar Altakrouri

Development of a mobile robot to study the collective behavior of zebrafish
F. Bonnet, P. Rétornaz, J. I. Halloy, A. Gribovskiy and F. Mondada

Balancing a dynamic public bike-sharing system
Contardo, Claudio, Catherine Morency, and Louis-Martin Rousseau

Engineering of software-intensive systems: State of the art and research challenges
Matthias Hölzl, Axel Rauschmayer, and Martin Wirsing

Alternating-time Temporal Logic
Rajeev Alur, Thomas A. Henzinger and Orna Kupferman

Taming Dynamically Adaptive Systems Using Models and Aspects
Brice Morin, Olivier Barais, Grégory Nain and Jean-Marc Jézéquel

PLEASE TAKE OUR
THREE MINUTE SURVEY
www.focas.eu/three-minute-survey
AND HELP DEFINE FUTURE CAS RESEARCH

Video Opinions

27 researchers have so far been interviewed: contact **Giacomo Cabri**: giacomo.cabri@unimore.it to contribute

Emil Vassev Interview

Fiona Polack Interview

Some Research Challenges relevant to Collective Adaptive Systems

Submit a challenge at: **www.focas.eu/research-landscape/challenges**

1. How to integrate robots and animals in the same system? Thomas Schmickl (EU)
2. How to deal with conflicting goals? Vincenzo Maltese (EU)
3. How to synthesize different CAS in an automatic way? Nicolas Markey (EU)
4. How can components be combined in CAS? Antonio Bucchiarone (EU)
5. How to achieve scalability? Stephen Gilmore (EU)
6. How to make automatic code diversification? Benoit Baudry (EU)
7. Building large CAS based on short-range communication only. James Sharpe (EU)
8. Attract users' fidelity to gather information and feedback. Nuno Luz (EU)
9. Keep it simple. Piet Hut (US)
10. How to make human-built entities (like cities) more cognitive? Onofrio Gigliotta (EU)
11. How to put together different areas, theories, scales? Fiona Polack (EU)
12. How to implement CAS for long-term self-maintenance? Dharani Punithan (ASIA)
13. How to enact feedback loops among heterogeneous entities? Giuseppe Valetto (EU)
14. Lack of theoretical foundations. Jacob Beal (US)
15. Apply interdisciplinary approaches to self-managing . Phan Cong Vinh (ASIA)
16. How to design the emergent adaptive behaviour of CAS. Emil Vassev (EU)
17. How to integrate the wide-range research areas involved. Gabrielle Peko (AUS)
18. How to overcome the lack of global view (holism) in complex systems. David Sundaram (AUS)
19. How to manage communication complexity. Sani Abba (ASIA)
20. How to achieve scalability. Sani Abba (ASIA)
21. How to migrate legacy, non-adaptable systems. Marco Mori (EU)
22. How can we maintain diversity and plasticity while collectively converging to a desired behaviour?
23. How can we recognise and accommodate individual failure in a collective system?
24. Does nature evolve globally through collaboration or does natural suppression caused by the success of competing entities cause global equilibrium rather than optimality?
25. Do biological, financial or political systems care about global improvement?
26. There is a cost to adaptation – how to balance this cost against the potential benefit?
27. The role of human heuristics in human-computer interactions. Can we design it using simple optimization or should we consider the typical human "dimensions"?
28. Does game theory apply in Evolutionary collective systems?
29. In Cloud Computing very interesting aspects to discuss are privacy and trust. Will be the same for CASs?
30. We have seen "classical frameworks for adaptation and several bio-ispired approaches for achiering adaptivity.It is possible to "merge" these different ways so to have a unified, more complete framework?
31. What is a useful example of a socially inclusive CAS?
32. Why is it sometimes impossible to predict a CAS' future behavior?
33. What preconditions are necessary to predict a CAS' future behavior?
34. What properties prevent any possibility to predict a CAS' future behavior? e.g. lead to chaos?

News from the projects

1st International Workshop on Business Processes in Collective Adaptive Systems (BPCAS 2014)

In conjunction with the 12th International Conference on Business Process Management (BPM 2014)

September 8, 2014, Haifa, Israel

Website: www.bpcas.org

ABOUT THE WORKSHOP

Collective Adaptive Systems (CAS) are heterogeneous collections of autonomous task-oriented systems that cooperate on common goals forming a collective system. To be robust, each constituent system must be able to dynamically adapt its behavior to changes in the environment while trying to reach their goals. At the same time, the different system adaptations must not be controlled centrally but rather administrated in a decentralized fashion among the systems. These aspects, collectiveness, adaptability and decentralisation are particularly relevant in businesses that wish to develop and deploy contextaware mobile applications that need to interact with pervasive technologies and cloud services. BPCAS aims to provide a forum for researchers, developers and users to meet and discuss the challenges and results in all areas related to collective adaptive systems. The workshop will seek papers offering new contributions in the theory, design, implementation and evaluation of CASs as well as experience papers and papers from industry. The workshop is organized by the EU ALLOW Ensembles project (http://www.allow-ensembles.eu). It is sponsored by the EU's Fundamentals of Collective Adaptive Systems programme initiative (http://focas.eu/about-focas/) that aims to integrate, coordinate and help increase visibility for research in all fields related to collective adaptive systems.

Topics of interest (but not limited to):

business process modeling for CAS

collective configuration of business processes in CAS

context/knowledge-aware business processes in CAS

collective adaptation and evolution in CAS

formal methods for CAS

distribution and mobility in CAS

big data in CAS

process similarity and emergent properties of CAS

security and privacy in CAS

machine learning and data mining techniques for CAS

optimization of CAS

frameworks, tools and programming paradigms for CAS

usability aspects of CAS

case studies and scenarios

ALLOW Ensembles

www.allow-ensembles.eu

PAPER SUBMISSION DETAILS

We invite submissions in two forms: full papers and position papers. Submitted papers must be written in English, should not have been submitted for review or published elsewhere, and should not exceed 12 pages for full papers, and 6 pages for position paper (including figures, bibliography and appendices). Submissions are accepted in PDF format via the EasyChair system. Submissions should be formatted according to the LNBIP format specified by Springer. All workshop papers will be published by Springer as a post-workshop proceedings volume in the series Lecture Notes in Business Information Processing (LNBIP). At least one author of each accepted paper is required to present the paper at the workshop.

IMPORTANT DATES

Submission deadline: June 1, 2014

Author notification: July 1, 2014

Camera-ready submission: July 23, 2014

Workshop date: September 8, 2014

WORKSHOP ORGANISATION

Organisers

Anna Lavygina, Imperial College London,UK

Naranker Dulay, Imperial College London, UK

Antonio Bucchiarone, Fondazione Bruno Kessler, Italy

Dimka Karastoyanova, University of Stuttgart, Germany

Muhammad Adnan Tariq, University of Stuttgart, Germany

Program Committee

To be announced.

FEATURED PUBLICATION

On-the-Fly Adaptation of Dynamic Service-Based Systems: Incrementality, Reduction and Reuse

A. Bucchiarone, A. Marconi, C. Antares Mezzina, M. Pistore, and H. Raik

ICSOC 2013, LNCS 8274, pp. 146–161. Springer, Heidelberg, 2013

ascens

www.ascens-ist.eu

autonomic service component ensembles

Blog: http://blog.ascens-ist.eu

FET Proactive Project 2010-2014

Partners:

Programming and Software Engineering Unit, LMU Munich: **Martin Wirsing** (coordinator)

Research Group on Concurrent Models of Computation, Università di Pisa: **Ugo Montanari**

Department of Statistics, Computer Science and Applications, Università di Firenze: **Rosario Pugliese**

Fokus, Fraunhofer Gesellschaft: Nikola Šerbedžija

Distributed and Complex Systems Group, Verimag Laboratory: **Saddek Bensalem**

Agent and Pervasive Computing Group, Università di Modena e Reggio Emilia: **Franco Zambonelli**

IRIDIA Group, Université Libre de Bruxelles: **Marco Dorigo**

Laboratoire de Systèmes Robotiques, EPFL: **Francesco Mondada**

Volkswagen's Group Research: **Henry Bensler**

Lero, the Irish Software Engineering Research Centre, University of Limerick: **Michael Hinchey**

Zimory GmbH: **Gustavo Alonso**

Institute of Advanced Studies Lucca, IMT: **Rocco De Nicola**

Robotic Systems Laboratory, Mobsya: **Michael Bonani**

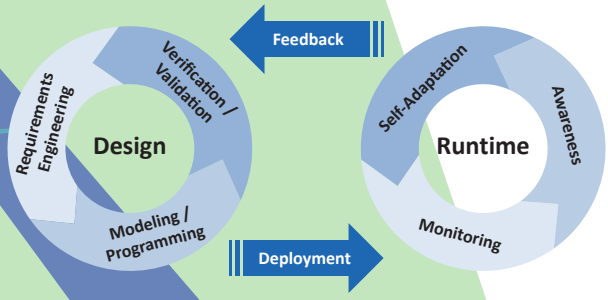
Department of Distributed and Dependable Systems, Charles University Prague: **František Plášil**

Istituto di Scienza e Tecnologie della Informazione "A. Faedo", ISTI: **Diego Latella**

FEATURED PUBLICATION

Reasoning (on) Service Component Ensembles in Rewriting Logic.
Lenz Belzner, Rocco De Nicola, Andrea Vandin, and Martin Wirsing.
In Shusaku Iida, José Meseguer, and Kazuhiro Ogata, editors, Specification, Algebra, and Software: A Festschrift Symposium in Honor of Kokichi Futatsugi (SAS 2014), 2014. To Appear, April 2014.

The ASCENS project aims at bringing awareness into technical systems. Formalisms, linguistic constructs and programming tools are being developed featuring high level of autonomous and adaptive behavior. These engineering tools are used in the different phases of the ensembles development life cycle (EDLC) for autonomic systems to address the issues posed by the diversity of self-* properties. The life cycle comprises a "double-wheel" and two "arrows" providing three different feedback loops: during offline design activities, during runtime and from these online activities back to design.



The ASCENS approach is both, pragmatic and formal. Pragmatic orientation means building autonomous systems that do practical things, like autonomous robot swarms performing rescue operation, autonomous cloud computing platforms transforming numerous small computers into a super computing environment or autonomous e-mobility support that ensures energy-aware transportation services. In reality, autonomous behavior means functioning without human intervention, seamlessly using own rules and criteria. At runtime, the more autonomy the system exhibits the less obvious it appears to outside observers. Thus to be sure about correct functioning of such systems it is necessary to develop formal methods and tools that can ensure not only that an autonomous system really does what it is supposed to do, but also that important conditions of the whole controlled environment are never violated. ASCENS offers a range of formal means that ensures modeling, formal reasoning, validation and verification of complex controlled systems, both in its design and at runtime.

ASCENS at ICT 2013

The ASCENS team presented a robot versus human competition. Not only that both robots - ASCENS and human controlled - worked perfectly, the response of the audience has been rewarding. We had many visitors, hundreds of questions and a lot of fun! See the videos at: **www.focas.eu/ict-2013**

ASSISI | bf have produced a varied suite of materials in their first year: eight publications, numerous blog entries, regular tweets, illuminating posters and challenging photographs and graphics detailing the interplay of bees, fish and robots. Furthermore, representatives of the 5 year project have participated in many events and attracted considerable press coverage.

Follow their progress via the ASSISI | bf blog or on Twitter at:

www.assisi-project.eu
@assisieu | #assisieu

ASSISI bf

Animal and robot Societies Self-organise and Integrate by Social Interaction (bees and fish)

FEATURED PUBLICATION

A general methodology for the control of mixed natural-artificial societies
Francesco Mondada, José Halloy, Alcherio Martinoli, Nikolaus Correll, Alexey Gribovskiy, Grégory Sempo, Roland Siegwart and Jean-Louis Deneubourg

In Handbook of collective robotics, Ed. Kerbach, S., Pan Stanford Publishing. (2013)

Organic computer systems consist of autonomous and cooperating subsystems

Organic Computing

Leibniz University Hannover
Christian Müller-Schloer | Mathias Pacher

Goethe University Frankfurt
Uwe Brinkschulte

Karlsruhe Institute of Technology
Michael Beigl | Wolfgang Karl | Sanaz Mostaghim
Hartmut Schmeck

University of Stuttgart: Frank Durr

University of Augsburg
Jorg Hahner | Wolfgang Reif | Sven Tomforde
Theo Ungerer

Munich Technical University: Andreas Herkersdorf

University of Paderborn
Bernd Kleinjohann | Franz-Josef Rammig

University of Lubeck
Erik Maehle | Christian Renner | Kay Romer

University of Rostok
Gero Muhl

Swiss federal Institute of Technology Zurich
Ingo Scholtes

University of Kassel
Bernhard Sick | Arno Wacker

University of Erlangen Nurnberg
ürgen Teich | Stefan Wildermann

Ruhr University Bocham
Rolf Wurtz

www.organic-computing.de

Cassting

collective adaptive systems synthesis with non-zero-sum games

Cassting events during year one:

Kim G. Larsen (Aalborg University) received the CAV award for the development of the toolsuite Uppaal. The CAV award is a presitigous award in automated verification.

Wolfgang Thomas (RWTH Aachen) received a honorary degree (Doctor Honoris Causa) from University of Mons.

Dietmar Berwanger (CNRS) organized the first edition of the international conference "Highlights in Automata, Logics and Games", in Paris. The event was a big success, gathering more than 200 researchers on these topics.

Thomas Brihaye (University of Mons) presented the Cassting project through a "course in game theory and applications" at the "Cité des Sciences" in Paris, on the occasion of a workshop on smart cities.

FEATURED PUBLICATION

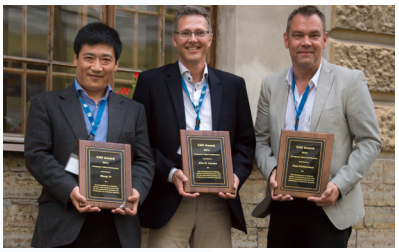
Lower-Bound Constrained Runs in Weighted Timed Automata
Patricia Bouyer, Kim G. Larsen, Nicolas Markey.
In Performance Evaluation, Elsevier Science Publishers, 2014. (To appear)

www.cassting-project.eu

Plans for year two:

Kim G. Larsen (Aalborg) and **Nicolas Markey** (CNRS) are organizing the 1st Cassting workshop in Grenoble, France, on April 12th. It will be a satellite workshop of the ETAPS conference, which is a big event in theoretical computer science. For details visit:

www.cassting-project.eu/workshop-2014



Also, **Wolfgang Thomas** (RWTH Aachen) will give an invited talk at the second international workshop on Strategic Reasoning (SR'14):

www.strategicreasoning.net

Interproject exchange

Cassting invited the Quanticol project (**Stephen Gilmore**, **Mirco Tribastone**) to attend a project meeting in Aalborg (Sept. 30th and Oct. 1st). Stephen gave a presentation of the Quanticol project during the meeting.

Smart Society

A new Smart Society website is up and running. The contemporary design presents publications, videos, slides, books and events, as well as key background information. Visit Smart Society at the web address below.

The project has also managed to publish a book in its first year, titled - **Provenance: An Introduction to PROV by Luc Moreau and Paul Groth.**

The four year project also has a CFP for a session at the 6th International Conference on Intelligent Decision Technologies, Greece (18-20 June) titled - Mastering Data-Intensive Collaboration through the Synergy of Human and Machine Reasoning. See website for full details.

www.smart-society-project.eu

hybrid and diversity-aware collective adaptive systems: when people meet machines to build a smarter society

FEATURED PUBLICATION

An Online Validator for Provenance: Algorithmic Design, Testing, and API
Moreau, Luc, Huynh, Trung Dong and Michaelides, Danius
17th International Conference on Fundamental Approaches to Software Engineering (FASE'14), 2014.

ecology-inspired software diversification

DIVERSIFY aims at favoring spontaneous diversification in software systems in order to increase their adaptive capacities. This objective is founded on three observations: software has to constantly evolve to face unpredictable changes in its requirements, execution environment or to respond to failure (bugs, attacks, etc.); the emergence and maintenance of high levels of diversity are essential to provide adaptive capacities to many forms of complex systems, ranging from ecological and biological systems to social and economical systems; diversity levels tend to be very low in software systems.

DIVERSIFY explores how the biological evolutionary mechanisms, which sustain high levels of biodiversity in ecosystems (speciation, phenotypic plasticity and natural selection) can be translated in software evolution principles. In this work, we consider evolution as a driver for diversity as a means to increase resilience in software systems. In particular, we are inspired by bipartite ecological relationships to investigate the automatic diversification of the server side of a client-server architecture. This type of software diversity aims at mitigating the risks of software monoculture. The consortium gathers researchers from the software-intensive, distributed systems and the ecology areas in order to transfer ecological concepts and processes as software design principles.

www.diversify-project.eu

FEATURED PUBLICATION

Empirical Evidence of Large-Scale Diversity in API Usage of Object-Oriented Software

Diego Mendez, Benoit Baudry, Martin Monperrus

In Proceedings of the International Conference on Source Code Analysis and Manipulation (SCAM'2013)

In this paper, Diversify study how object-oriented classes are used across thousands of software packages.

They concentrate on 'usage diversity', defined as the different statically observable combinations of methods called on the same object. Even though most classes are used in a small number of ways, we observe a large number of classes with a significant usage diversity. For instance, we observe in our dataset that Java's String is used in 2460 manners.

They leverage state of the art biodiversity analysis techniques to get insights about this diversity. They observe that the entropy of usage, i.e., the distribution of usages, is very high and very often close to the theoretical maximum, indicating that there is a true diversity in usage; the diversity of usage does not depend on the number of methods in the API; the lattice of usages of a class is an indicator of the number of responsibilities in of the class.

They further discuss software engineering practices and constraints that might encourage the emergence of this natural form of software diversity, as well as the potential implications of this diversity on software quality.

The authors:

Diego Mendez is a Masters student in Computer Science in Argentina who was an intern at INRIA when he developed and ran the experiments for this paper

Benoit Baudry is the coordinator of the DIVERSIFY project

Martin Monperrus' research focuses on empirical software analysis and bug repair. He is a co-PI for the DIVERSIFY project.

Importance for FOCAS

Within FOCAS, the DIVERSIFY project focuses on the software foundations that underly the emergence of diversity in CAS. The essential intuition of the project is that high degrees of diversity are essential to sustain the adaptive capacities of CASs, in the same way as biodiversity is an essential property of ecological systems to ensure their resilience in the face of unpredictable events.

The paper provides major insights about one form of software diversity that spontaneously emerges through large-scale software development. These observations indicate that software APIs tend to be naturally very plastic, i.e., they can be used in a large number of ways, offering great opportunities for adapting the usage of an API to a specific context.

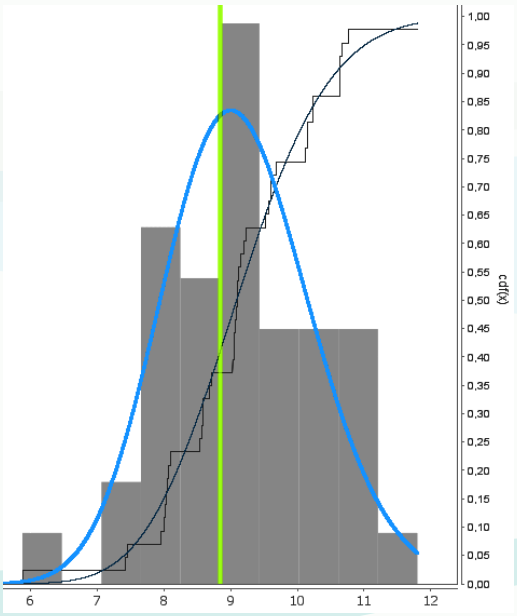
a quantitative approach to management and design of collective adaptive behaviours

quanticol

Case Study: Model-checking Edinburgh buses

One of the case studies in the QUANTICOL project is concerned with modelling and analysing the public transport system in the city of Edinburgh, with a specific focus on the bus network. Buses in Edinburgh are thoroughly instrumented with GPS positioning instrumentation, and report their latitude and longitude every thirty seconds back to a central server which uses a predictive model to estimate arrival times at bus stops. These predictions are relayed back to passengers of the bus service using on-street signage, made accessible via a web site, and delivered by smartphone apps.

The Traffic Commissioner for Scotland sets standards for bus operators mandating the percentage of buses which should be on-time for services (that is, they depart from their stop no more than one minute early and no more than five minutes late for specific timing points along the route). The gravity and seriousness of these definitions was made clear when the Traffic Commissioner for Scotland held a public enquiry into the operation of Edinburgh's Lothian Buses in response to a complaint about buses running too early. The public enquiry and the subsequent decision of the Traffic Commissioner were reported in national newspapers.

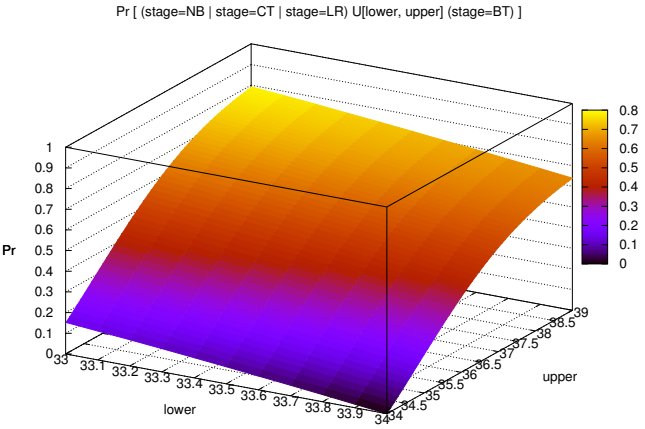


Using measurement data from the city's automatic vehicle location service, the QUANTICOL project has been able to build accurate stochastic models of Edinburgh's bus services. Using this it is possible to determine whether potential changes to their service would expose a bus company to liability in the future.

The first step was to find an appropriate stochastic model which would capture the variability in the bus service due to delays which occur for operational reasons such as traffic conditions, passenger boarding and alighting, and road congestion. Empirical distributions of journey times were used as an input for the HyperStar tool for fitting phase-type distributions to data sets, producing a phasetype stochastic process as the result.

Phase-type distributions have the desirable property that they can approximate any distribution with non-negative support arbitrarily closely and can also be represented as continuous time Markov chains. This allowed the QUANTICOL researchers to reformulate the problem as a modelchecking problem and verify probabilistic logic formulae against this model.

This efficient modelling method meant that the researchers on the project can compute the probability of completing a journey within a specified window of tolerance on arrival times. Varying the upper and lower bounds on the time of arrival allows the modellers to see whether the bus service could operate under stricter terms of operation or whether there is no potential for this because they are already near to failing to meet their targets for on-time arrivals.



A future modelling problem is the representation of hybrid buses which, in addition to meeting theirtime bound on arrival, would like to arrive within the energy bound imposed by the capacity of their battery. Representing these two dimensions in the model will be a new challenge for the QUANTICOL project to tackle. **Stephen Gilmore**

blog.inf.ed.ac.uk/quanticol

The Swarm-Organ project consolidates

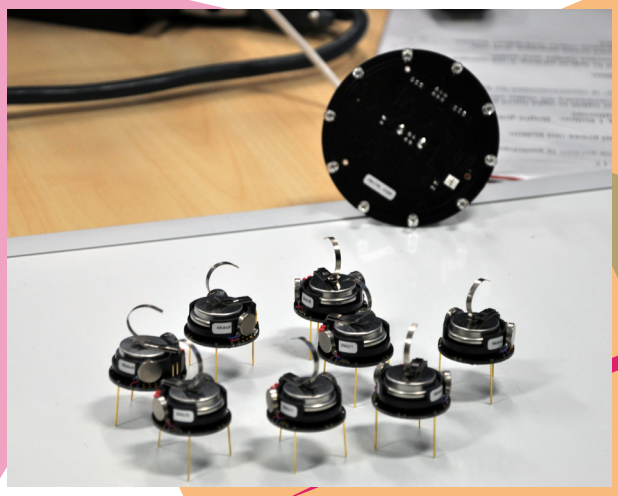
Joaquim Calbó, Swarm-Organ project manager, Centre for Genomic Regulation

Just a few months after kick-off, the swarm of researchers involved in this FP7-funded project is certainly self-organizing into a unified and powerful research organ. Its goal is to develop a theoretical framework for the distributed adaptive control of relatively simple agents, based on gene regulatory networks. Reaching this degree of integration relatively early in the project has been due to the enthusiastic drive of the consortium members, allowing the following objectives to be achieved:

1) Identify the participating agents: Several researchers (PhD students and postdocs) have joined the group, each of whom brought essential expertise and fresh ideas. Now the swarm consists of 15 (not-so-simple) agents with strong backgrounds in diverse disciplines, including computational science, robotics, developmental biology, engineering, and informatics.

2) Establish reliable communication protocols: Communication paths have been established, both external (see www.swarm-organ.eu) and internal (intranet and wiki, mailing lists, and Git resource for collaborative software development). Still, the most successful and important interactions were achieved through the frequent project meetings that have already taken place: almost all members of the project have met in person at four meetings, each hosted by one of the partner institutions.

a theoretical framework for swarms of GRN-controlled agents which display adaptive tissue-like organisation



3) Design and implement the first tasks: In the first meeting (June 2013), held in Barcelona and hosted by James Sharpe (Centre for Genomic Regulation, CRG), the aims and conceptual basis for the project were discussed and settled. This opening meeting was immediately followed by the first FoCAS Inter-Project meeting, which presented the project members with a great opportunity to network with several experts in Collective Adaptive Systems and to identify potential synergies between projects. In the second meeting (August 2013), held in Guilford and hosted by Yaochu Jin (University of Surrey), Swarm-Organ researchers addressed the initial research challenge, i.e. choosing the robotic platform and simulator. In the following meeting held in Amsterdam and hosted by Jaap Kaandorp (University of Amsterdam, October 2013), the preliminary results obtained with the agreed-upon simulator and basic constraints were discussed, and the main pitfalls analysed in detail. Finally, in the fourth meeting (November 2013), held in Norwich and hosted by Verônica Grieneisen (John Innes Centre), a lot of new results were shared, important decisions regarding the election of the standard model to be used in the rest of the project were taken, and, most excitingly, the first live tests with real robots were performed.

This new research team/swarm/organ is now fully functional; in fact, it has already reached the first established milestone for the project ahead of time. The expectation for the outcomes of the project are high with regards to elucidating the underlying rules that define the collective behaviour of single agents, which may apply both to biological systems (i.e. morphogenesis) and to the next generation of technologies in robotics and computation. We should keep an eye on the endeavours of this swarm.....

www.swarm-organ.eu

The Sound of a Booksprint

by **Gusz Eiben**

The idea was offered in the morning, but it sounded like one of those late night thoughts after a few drinks: write a book in five days. Yes, from zero to book in less than a week. It happened in a Brussels café, where we, "FoCAS people" met some Unidentifiable Friendly Objects – guys who did not easily fit in the usual scientific categories. They were not junior mathematicians or senior biologists, professors or postdocs. Their descriptors were different and vague to me. I heard hints about art, humanities, SMEs, open source activism, all in all, a refreshing company that offered a refreshing idea.

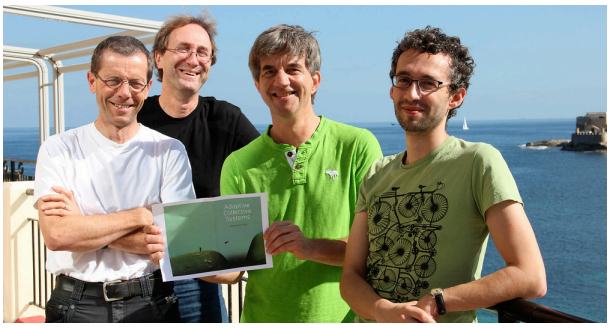
The idea became serious when we became partners. The UFOs transformed into participants of the new EU project called Booksprint for ICT Research, BS4ICTRSRCH. (Say that five times fast.) Both projects, the FoCAS CA and BS4ICTRSRCH, included a FOCAS Booksprint into their official work plans and the refreshing idea became a contractual obligation.

The idea became reality in Malta last November. To make it happen, a group of five FoCAS domain experts and seven BS4ICTRSRCH facilitators gathered in a beach hotel. The setting was nice, the spirit was great, and several crucial elements were in place.

First, the experts covered a wide spectrum, ranging from a hard-core computer scientist in distributed computing to a social informatics professor, with some bio-inspired AI folks (including me) in the middle. This fuelled lively discussions, sometimes clashing strong opinions and often surprising agreements. Second, the group of facilitators included a graphic designer. Unexpectedly to me, he was instrumental. He quickly turned vague ideas and much hand waving into nice visuals and helped us converge on catchy messages and metaphors – see the cover of the book. Last, but not least, we made insane working hours from 8:30 till midnight. Massive congrats to the facilitators who got us into this with great professionalism. No whip, but a smile –and a bottle of red around 10pm...

The idea became history after that week. The book was finished, the rush was gone. Then a request came to write about it. How did you pull it all out? How was it to be there? How is the look, the feel, the sound of a Booksprint? As for the look: follow the link below. As for the feel: unique. As for the sound: silent. The only thing you hear is the soft clicks of the laptop keybords.

Download/read the book and find out more about Booksprint at the FoCAS website: www.focas.eu/adaptive-collective-systems-book



FUNDAMENTALS OF COLLECTIVE ADAPTIVE SYSTEMS

FoCAS

FoCAS supported projects:

ALLOW ENSEMBLES - www.allow-ensembles.eu
New design principles for large-scale collective systems

ASCENS - www.ascens-ist.eu
Autonomic service-component ensembles

ASSISI | BF - www.assisi-project.eu
Animal and robot Societies Self-organise and Integrate by Social Interaction

CASSTING - www.cassting-project.eu
Collective Adaptive System SynThesIs with Non-zero-sum Games

DIVERSIFY - www.diversify-project.eu
Ecology-inspired software diversity for distributed adaptation in CAS

ORGANIC COMPUTING
www.organic-computing.de
Organic computer systems consist of autonomous and cooperating subsystems

QUANTICOL - blog.inf.ed.ac.uk/quanticol
A Quantitative Approach to Management and Design of Collective and Adaptive Behaviours

SMARTSOCIETY - www.smart-society-project.eu
Hybrid and Diversity-Aware Collective Adaptive Systems

SWARM-ORGAN - www.swarm-organ.eu
A theoretical framework for swarms of GRN-controlled agents which display adaptive tissue-like organisation

FoCAS coordinates the research of 9 research projects, but anyone or group can join if they have a research interest in Collective Adaptive Systems:

www.focas.eu

FoCAS project partners

Centre for Emergent Computing
(Edinburgh Napier University, UK)

Computational Intelligence Group
(VU University, Amsterdam)

Agent and Pervasive Computing Group
(University of Modena & Reggio Emilia, Italy)

Intelligent Systems & Networks Group
(Imperial College London)

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.

Twitter: @FETFoCAS | #FETFoCAS

FoCAS is a FET FP7 project 2013-2016

COOPERATION

Triangles throughout newsletter courtesy of a Kevin Sim program