

# FAS\* 2016

Foundations and Applications of Self\* Systems

SASO 2016: IEEE 10th International Conference on Self-Adaptive and Self-Organizing Systems

ICCAC 2016: International Conference on Cloud and Autonomic Computing

FAS\*W 2016: IEEE 1st International Workshops on Foundations and Applications of Self\* Systems

Augsburg, Germany · September 12-16, 2016





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# Program at a Glance

	Monday			Tuesday	
9:00 – 9:30	Note: Some workshops start earlier. Please see the workshops' web pages			<b>Conference Welcome</b> <i>1001T</i>	
9:30 – 10:30	<b>Workshops</b> eCAS, <i>1003T</i> AMGCC'16, <i>2001T</i> QA4SASO, <i>2002T</i>	<b>Tutorial</b> Knowledge Level Models of Situations and Situation Assessment <i>2004T</i>	<b>Special Track</b> Trustworthy Open Self-Organizing Systems <i>1005T</i>	<b>Keynote Marco Dorigo</b> Collective Decision Making: The Best-of-n Problem in Robot Swarms <i>1001T</i>	
10:30 – 11:00	Coffee Break				
11:00 – 12:30	<b>Workshops</b> eCAS, <i>1003T</i> AMGCC'16, <i>2001T</i> QA4SASO, <i>2002T</i>	<b>Tutorial</b> Knowledge Level Models of Situations and Situation Assessment <i>2004T</i>	<b>Special Track</b> Trustworthy Open Self-Organizing Systems <i>1005T</i>	<b>SASO</b> Session 1: Swarm Robotics <i>1001T</i>	<b>ICCAC</b> Session 1: Scheduling and Allocation <i>1002T</i>
12:30 – 14:00	Lunch Break				
14:00 – 15:30	<b>Workshops</b> eCAS, <i>1003T</i> AMGCC'16, <i>2001T</i> QA4SASO, <i>2002T</i> DSS, <i>2003T</i>	<b>Tutorial</b> Model-based Cloudification of Critical Applications <i>2004T</i>	<b>Special Track</b> Trustworthy Open Self-Organizing Systems <i>1005T</i>	<b>SASO</b> Session 2: Agents and Learning <i>1001T</i>	<b>ICCAC</b> Session 2: Data Management <i>1002T</i>
15:30 – 16:00	Coffee Break				
16:00 – 17:30	<b>Workshops</b> eCAS, <i>1003T</i> AMGCC'16, <i>2001T</i> QA4SASO, <i>2002T</i> DSS, <i>2003T</i>	<b>Tutorial</b> Model-based Cloudification of Critical Applications <i>2004T</i>	<b>Special Track</b> Trustworthy Open Self-Organizing Systems <i>1005T</i>	<b>SASO</b> Session 3: Spatial Computing <i>1001T</i>	<b>ICCAC</b> Session 3: Storage and Small Business, and Other Short Papers <i>1002T</i> (until 18:00)
	City Tour: Meeting point in front of the Physik Hörsaalzentrum at 17:30.				
19:00 – 22:00	Welcome Reception				

# Program at a Glance

Wednesday	Thursday	Friday			
		Note: Some workshops start earlier. Please see the workshops' web pages			
<b>Keynote Manish Gupta</b> Using Data Science and Cloud to Scale and Personalize Services <i>1001T</i>	<b>Keynote Dominik Bösl</b> Future of Robotics – Paving the Way for a Generation 'R' of Robotic Natives in the Age of Digitalization <i>1001T</i>	<b>Workshops</b> SASO <sup>A</sup> ST, <i>1003T</i> SOCO, <i>1005T</i> FMEC/ISCW, <i>2002T</i> DSPL, <i>2003T</i>	<b>Tutorial</b> Context for Adaptive Information Fusion <i>2004T</i>	<b>Special Track</b> DREAMing – Optimization and Learning of Robotic Tasks in Simulation <i>2001T</i>	
Coffee Break					
<b>SASO</b> Session 4: Institutions and Organi- zations <i>1001T</i>	<b>ICCAC</b> Session 4: System Manage- ment <i>1002T</i>	<b>SASO</b> Session 5: Resource Management <i>1001T</i>	<b>Workshops</b> SASO <sup>A</sup> ST, <i>1003T</i> SOCO, <i>1005T</i> FMEC/ISCW, <i>2002T</i> DSPL, <i>2003T</i>	<b>Tutorial</b> Context for Adaptive Information Fusion <i>2004T</i>	<b>Special Track</b> DREAMing – Optimization and Learning of Robotic Tasks in Simulation <i>2001T</i>
Lunch Break					
<b>Posters and Demo</b> Lightning Talks <i>1001T</i>	<b>SASO</b> Session 6: Short Papers <i>1001T</i>	<b>Doctoral Symposi- um</b> Invited Talk and Panel Discussion <i>1005T</i>	<b>Workshops</b> SASO <sup>A</sup> ST, <i>1003T</i> SOCO, <i>1005T</i> FMEC/ISCW, <i>2002T</i> DSPL, <i>2003T</i>	<b>Tutorial</b> Solving Soft Constraint Problems in Autonomic Systems with MiniBrass <i>2004T</i>	
Coffee Break					
<b>Posters and Demo</b> Poster Presentations <i>Foyer</i>	<b>Doctoral Symposium</b> Paper Presentations <i>1005T</i>		<b>Workshops</b> SOCO, <i>1005T</i> FMEC/ISCW, <i>2002T</i> DSPL, <i>2003T</i>	<b>Tutorial</b> Solving Soft Constraint Problems in Autonomic Systems with MiniBrass <i>2004T</i>	
	<b>SASO Conference Closing</b> <i>1001T</i>				
Conference Dinner					

# Keynote: Tuesday, 9:30 – 10:30

## Marco Dorigo

Université Libre de Bruxelles, BE

### Collective Decision Making: The Best-of-n Problem in Robot Swarms

Tuesday, September 13, 9:30 – 10:30  
1001T

#### Abstract:

Achieving fast and accurate collective decisions with a large number of simple agents without relying on a central planning unit or on global communication is essential for developing complex collective behaviours. In this talk, I will overview recent research done in my lab on collective decision making in robot swarms. In particular, I will present ad hoc and opinion-based methods for the solution of a few variants of the best-of-n problem. I will discuss the results of real robot experiments and show how different types of modelling techniques can help us understanding the dynamics of the swarm collective decisions.

#### Biography:

Marco Dorigo received his PhD degree in electronic engineering in 1992 from Politecnico di Milano, Milan, Italy. In 1995 he received the title of Agrégé de l'Enseignement Supérieur (professorship qualification) from the Université Libre de Bruxelles, Brussels, Belgium. From 1992 to 1993, he was a Research Fellow at the International Computer Science Institute, Berkeley, CA. In 1993, he was a NATO-CNR Fellow, and from 1994 to 1996, a Marie Curie Fellow. Since 1996, he has been a tenured researcher of the FNRS, the Belgian National Funds for Scientific Research, and a co-director of IRIDIA, the artificial intelligence laboratory of the Université Libre de Bruxelles.

Prof. Dorigo is the inventor of the ant colony optimization metaheuristic. His current research interests include swarm intelligence, swarm robotics, and metaheuristics for discrete optimization. At IRIDIA he leads a group of approximately twenty researchers who investigate various aspects of swarm intelligence and of its application to robotics, networks and optimization problems. He is the Editor-in-Chief of Swarm Intelligence, an Associate Editor of the IEEE Transactions on Evolutionary Computation, of the IEEE Transactions on Cybernetics, of the IEEE Transactions on Autonomous Mental Development, of the ACM Transactions on Adaptive and Autonomous Systems, and a member of the Editorial Board of many journals on computational intelligence and adaptive systems.

As a result of his numerous scientific contributions, Prof. Dorigo was awarded numerous international prizes, among which the Italian Prize for Artificial Intelligence in 1996, the Marie Curie Excellence Award in 2003, the Dr. A. De Leeuw-Damry-Bourlart Award in Applied Sciences in 2005, the Cajastur International Prize for Soft Computing in 2007, an European Research Council Advanced Grant in 2010, the IEEE Frank Rosenblatt Award in 2015, and the IEEE CIS Evolutionary Computation Pioneer award in 2016.

Prof. Dorigo is a fellow of the Institute of Electrical and Electronics Engineers (IEEE), of the Association for the Advancement of Artificial Intelligence (AAAI), and of the European Coordinating Committee for Artificial Intelligence (ECCAI).

# Keynote: Wednesday, 09:30 – 10:30

**Manish Gupta**

Xerox Research Center India, IN

## Using Data Science and Cloud to Scale and Personalize Services

Wednesday, September 14, 9:30 – 10:30

1001T

### Abstract:

Many services, such as healthcare and education are highly human-intensive offerings that remain inaccessible (at acceptable quality level) to large numbers of people. With increasing digitization of the world and easy availability of computational power over the cloud, there is an opportunity to apply data science to transform these services. We begin by describing a dire need and an opportunity to improve the healthcare system worldwide by supporting a shift from reactive treatment to more proactive action. As examples of what is possible, we present new machine learning techniques to predict a class of complications in an ICU, and to identify patients in a hospital who are likely to require ICU admission. We also present work that shows the applicability of remote sensing and data analytics to measure body vitals, such as respiration and heart rate, to screen for diseases, and to reduce the need for people to visit a hospital. We then describe a cloud-hosted system called TutorSpace to help with personalization and improved navigation of videos from massive open online courses to enable more effective learning. Finally, we present data-driven techniques to improve public transportation services and to enable cities to reduce traffic congestion while offering a range of transportation options to their citizens. We frame all of the above efforts as examples of using data science and cloud to offer personalized services at scale. We describe some outstanding challenges that need to be met to achieve truly transformational impact.

### Biography:

Dr. Manish Gupta is Vice President at Xerox Corporation and Director of Xerox Research Centre in India. Previously, Manish has served as Managing Director, Technology Division at Goldman Sachs India, and has held various leadership positions with IBM, including that of Director, IBM Research - India and Chief Technologist, IBM India/South Asia. From 2001 to 2006, he served as a Senior Manager at the IBM T.J. Watson Research Center in Yorktown Heights, New York, where he led the team developing system software for the Blue Gene/L supercomputer. IBM was awarded a National Medal of Technology and Innovation for Blue Gene by US President Barack Obama in 2009. Manish holds a Ph.D. in Computer Science from the University of Illinois at Urbana Champaign. He has co-authored about 75 papers, with more than 6,000 citations in Google Scholar in the areas of high-performance computing, compilers, and virtual machine optimizations, and has been granted 19 US patents. While at IBM, Manish received an Outstanding Innovation Award, two Outstanding Technical Achievement Awards and the Lou Gerstner Team Award for Client Excellence. Manish serves as the chair of IKDD, the ACM India Special Interest Group on Knowledge Discovery and Data Mining, and was General Co-Chair for IKDD Conference on Data Sciences 2015. He is an ACM Fellow, a Fellow of the Indian National Academy of Engineering, and a recipient of a Distinguished Alumnus Award from IIT Delhi.

# Keynote: Thursday, 9:30 – 10:30

**Dominik Bösl**

KUKA AG, DE

## **Future of Robotics – Paving the Way for a Generation ‘R’ of Robotic Natives in the Age of Digitalization**

Thursday, September 15, 9:30 – 10:30  
1001T

### **Abstract:**

Humankind is facing disruptive technological innovation, e.g., in the fields of robotics, automation and artificial intelligence. These changes will prove to have at least as much impact on society over the next half a century as the Internet and mainstream IT technology had over the last 50 years. As we are facing a great chance of addressing possibly arising issues in advance – involving self-regulation in the sense of Technology Governance – these challenges have to be discussed on a broad, fact based and interdisciplinary level. The talk will discuss the future of robotics, automation and artificial intelligence. It will explain, why our grandchildren will grow up as the first Generation ‘R’ of Robotic Natives and suggest the concept of Technology & Robotic Governance as a means of self-regulation when dealing with these disruptive technologies. It will also touch the importance of self-organization and self-adaption as enabling technologies for autonomous robotic systems.

### **Biography:**

Dominik Bösl has been responsible for Innovation and Technology Management at KUKA since he first joined KUKA Laboratories as Head of Corporate Strategy and Member of the Board in 2011. In 2012, he became Corporate Innovation Manager at KUKA AG, directly reporting to the Management Board. His responsibility for all innovation efforts spans the entire KUKA group. As one of KUKA’s Technology Owners (equivalent to other companies’ Technical Fellows or Distinguished Engineers), he defines the group’s strategy for “Apps, Cloud & IoT”.

In 1999, Dominik started his career at Siemens, where he helped establish the foundations of today’s mobile ecosystem by bringing the first UMTS broadcasting cell to market, before joining Microsoft Germany in 2005. At Microsoft, he held various leading positions with national responsibility in developer evangelism. Instead of moving to Seattle for a leading position in program management at Microsoft Corporation, he decided to join the KUKA group.

Dominik graduated with a diploma in Computer Science from the University of Augsburg and an MBA degree from the University of Pittsburgh. In addition to his career, he has constantly been lecturing at different universities and is author of technical and scientific publications.

In his spare time, he publishes educational concepts on serious gaming and works as head of a charity organization that maintains AntMel!, one of the world’s most successful serious games. He takes a particular interest in the future of Robotics and Automation and their impact on society. At Munich Technical University (TUM) he researches the genesis of a new Generation ‘R’ of “Robotic Natives” and why self-regulation in the form of Technology & Robotic Governance will be crucial.

# Venue Information

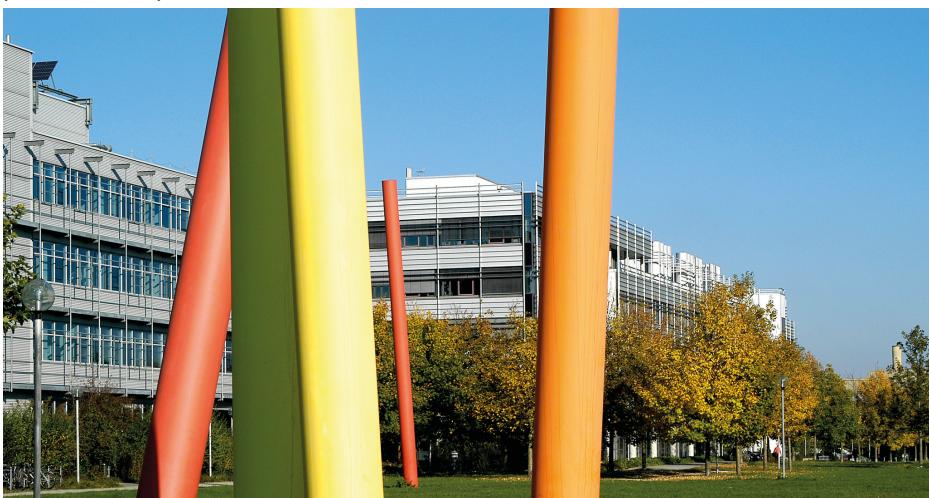
## University of Augsburg

Founded in 1970, the University of Augsburg is counted among the younger universities of Germany. Nevertheless, it comprises seven faculties, with the Faculty of Applied Computer Science being the third biggest of its kind in Bavaria. Surrounded by other research and technology centres, the campus of the university is situated on the southern edge of Augsburg's city centre. It can easily be reached by tram within 10-15 minutes from Königsplatz or the central station (line 3, direction Haunstetten West).



## Physics

Although this year's FAS\* is hosted by the Institute for Software & Systems Engineering, the Institute of Physics kindly provides the facilities for the conference. Augsburg's Institute of Physics is especially known for its fundamental research into solid-state physics. The Physik Hörsaalzentrum, which constitutes the actual venue of the conference, is situated at the heart of the Faculty of Mathematics, Natural Sciences, and Materials Engineering at the southern part of the campus.



# Social Events

## Welcome Reception at the Town Hall Monday, September 12, 19:00

The welcome reception will take place at the town hall in the city centre. As one of the most considerable secular Renaissance buildings in Central Europe, the Augsburger Rathaus is one of the most beautiful sights of the city.

The participants will be picked up at the University by tram and, after a short city tour, be taken directly to the town hall. There, the Welcome Reception will be accompanied by food and live music.



## Bavarian Night at the Kurhaus Wednesday, September 14, 19:00

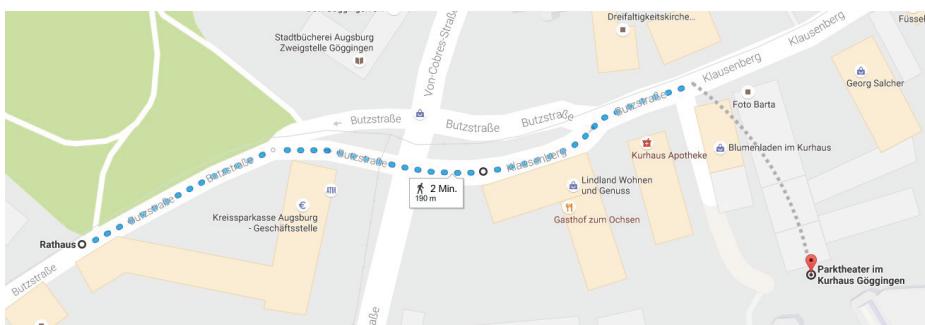
This year's conference dinner will be inspired by the famous Munich Oktoberfest. By means of traditional Bavarian food, drinks and music, the participants will get to know the cultural peculiarities of southern Germany.

The conference dinner will be hosted at the Kurhaus in Göppingen in the south-west of the city. The Kurhaus is a multifunctional theatre of cast iron and glass construction, built in the style of late 19th-century Historicism. For directions from the University, please see below.



## Your route to the Kurhaus:

Tram line 3 (direction Stadtbergen) from University to Königsplatz. At Königsplatz, change to tram line 1 (direction Göppingen) to the station Göppingen Rathaus, from where you easily reach the Kurhaus after a short walk. The map shows the directions from the Göppingen Rathaus (see "Rathaus") to the Kurhaus (see "Parktheater im Kurhaus Göppingen").





# SASO 2016

## IEEE 10th International Conference on Self-Adaptive and Self-Organizing Systems

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# Message from the Program Chairs

It is our pleasure to welcome you to the tenth edition of SASO, the IEEE International Conference on Self-Adaptive and Self-Organizing Systems. SASO 2016 is hosted at the University of Augsburg, Germany from the 12th to the 16th of September 2016.

This year, we have broadened the topics in the call for papers in order to also attract interesting papers from fields that are connected to the area of self-adaptive and self-organizing systems. In particular, we have added topics about smart industries, smart vehicles, and data-driven approaches, such as data mining, machine learning, data science and other statistical techniques to analyse, understand, and manage the behaviour of complex systems.

We received 80 abstracts of which 65 were followed by submissions of full papers. This number of submission is in line with the previous editions of SASO (47 in 2015, 61 in 2014, 64 in 2013), pointing out the consolidation of the conference but also a slightly positive trend.

After an extensive review process, we decided to accept 14 full papers corresponding to an acceptance rate of about 21%, in line with previous editions and also re-emphasizing the high quality of SASO papers. We also accepted 6 short papers which were deemed to be of interest to the SASO community but were not yet at the quality standard to be accepted as full papers.

The conference program also includes a poster and demo session, which received 25 submissions; these submissions were reviewed by a separate program committee. Papers submitted to SASO that were not accepted but considered to be interesting preliminary work were recommended to be transferred to the poster session or to the workshops affiliated to SASO.

The accepted papers will be presented in five sessions, each of which characterized by a theme. The first session is about *Swarm Robotics* and will include papers presenting approaches to the management of swarms and of robots. The second session is related to *Agents and Learning*, in which papers about exploiting agents for load shedding and learning for emergent systems and open networks will be presented. *Spatial Computing* is the theme

of the third session, in which adaptation takes spatial aspects into consideration. In the fourth session, *Institutions and Organizations*, the presentations will concern adaptation of SASO principles in institutions and organizations in general. The last session is about *Resource Management*, with papers addressing decision making and self-organization in cloud environments and in resource allocation. Finally, the session on short papers will complete the conference.

The Program Committee was composed of 47 international experts in different fields of self-adaptive and self-organizing systems. We would like to thank them for their valuable work, not only in reviewing papers, but also in discussing and helping us in the selection of papers to be accepted.

As in the two previous editions, this year's SASO is part of a federation of conferences called FAS\* – Foundations and Applications of Self\* Systems, including the International Conference on Cloud and Autonomic Computing. All of the FAS\* events will be hosted at the University of Augsburg and the SASO program will include invited talks shared with FAS\*, all of which are of interest to the SASO audience.

Finally, we would like to express our deep gratitude to everyone who contributed to the organisation of SASO 2016. We thank the Steering Committee and the PC chairs of previous SASO editions for their help, support, and feedback. We also thank the people who worked with us on the Technical Committee, in particular, Wolfgang Reif, Gerrit Anders and Hella Seebach for their valuable organization, Jean Botev for the collaboration with the Poster and Demo session, Christian Müller-Schloer and Peter Lewis for the workshop management, Kyle Usbeck for the publication process, Jan-Philipp Steghöfer for the publicity, and Matthias Tichy for the conference web site.

Giacomo Cabri, Università di Modena e Reggio Emilia, IT

Gauthier Picard, MINES Saint-Étienne, FR

Niranjan Suri, Florida Institute for Human & Machine Cognition (IHMC), USA

# Sessions on Tuesday

## Session 1: Swarm Robotics

**Tuesday, September 13, 11:00 – 12:30**  
1001T

Chair: Salima Hassas

Controlling Swarms by Visual Demonstration  
Karan Budhraja  
Tim Oates

Online Hyper-Evolution of Controllers in  
Multirobot Systems

Fernando Silva  
Luís Correia  
Anders Lyhne Christensen

An Evolutionary Robotics Approach to the  
Control of Plant Growth and Motion:  
Modeling Plants and Crossing the Reality  
Gap

Mostafa Wahby  
Daniel Nicolas Hofstadler  
Mary Katherine Heinrich  
Payam Zahadat  
Heiko Hamann

## Session 2: Agents and Learning

**Tuesday, September 13, 14:00 – 15:30**  
1001T

Chair: Jake Beal

Flexible Load Shedding using Gossip  
Communication in a Multi-Agents System  
Victor Lequay  
Mathieu Lefort  
Saber Mansour  
Salima Hassas

Losing Control: The Case for Emergent  
Software Systems using Autonomous  
Assembly, Perception and Learning

Barry Porter  
Roberto Rodrigues Filho

Learning in Open Adaptive Networks

Guoli Yang  
Vincent Danos

## Session 3: Spatial Computing

**Tuesday, September 13, 16:00 – 17:30**  
1001T

Chair: Ada Diaconescu

Self-Adaptation to Device Distribution  
Changes

Jacob Beal  
Mirko Viroli  
Danilo Pianini  
Ferruccio Damiani

On the Importance of Spatial Perception for  
the Design of Adaptive User Interfaces

Tilman Deuschel  
Ted Scully

# Sessions on Wednesday

## Session 4: Institutions and Organizations

**Wednesday, September 14, 11:00 – 12:30**

*1001T*

Chair: Mirko Viroli

Distributed Distributive Justice

David Birth Kurka

Jeremy Pitt

Inter-Institutional Social Capital for

Self-Organising 'Nested Enterprises'

Patrício Petrucci

Jeremy Pitt

Dídac Busquets

Goal-Oriented Holonics for Complex System

(Self-)Integration: Concepts and Case Studies

Ada Diaconescu

Sylvain Frey

Christian Müller-Schloer

Jeremy Pitt

Sven Tomforde

# Sessions on Thursday

## Session 5: Resource Management

**Thursday, September 15, 11:00 – 12:30  
1001T**

Chair: Christian Müller-Schloer

Self-Optimising Decentralised Service Placement in Heterogeneous Cloud Federation

Emanuele Carlini

Massimo Coppola

Patrizio Dazzi

Matteo Mordacchini

Andrea Passarella

Self-Organized Graph-Based Resource Allocation

Gerrit Anders

Patrick Lehner

Hybrid Planning for Decision Making in Self-Adaptive Systems

Ashutosh Pandey

Gabriel Moreno

Javier Cámaras

David Garlan

## Session 6: Short Papers

**Thursday, September 15, 14:00 – 15:30  
1001T**

Chair: Jeremy Pitt

Evaluating Connection Resilience for Self-Organizing Cyber-Physical Systems

Henner Heck

Olga Kieselmann

Arno Wacker

Towards Linking Adaptation Rules to the Utility Function for Dynamic Architectures

Sona Ghahremani

Holger Giese

Thomas Vogel

One Swarm per Queen: A Particle Swarm Learning for Stochastic Games

Alain Tcheukam Siwe

Hamidou Tembine

Decentralized Cluster Detection in Distributed Systems based on Self-Organized Synchronization

Vikramjit Singh

Markus Esch

Ingo Scholtes

Interaction-Awareness for Self-Adaptive Volunteer Computing

Abdessalam Elhabbash

Rami Bahsoon

Peter Tino

Ensemble Time Series Forecasting with XCSF

Matthias Sommer

Anthony Stein

Jörg Hähner

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Paul Robertson, Dynamic Object Labs, USA  
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Harald Roelle, Siemens, DE

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Kirstie Bellman, The Aerospace Corporation, USA

## Demonstrations and Posters Chair

Jean Botev, University of Luxembourg, LU

## Doctoral Symposium Chair

Ingo Scholtes, ETH Zurich, CH

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Matthias Tichy, University of Ulm, DE

## Local Arrangements Chair

Hella Seebach, ISSE, University of Augsburg, DE

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(ISSE, University of Augsburg, DE)  
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Oliver Kosak  
Alexander Schiendorfer  
Florian Siefert

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Rene Meier, Lucerne University of Applied Sciences, CH  
James Michaelis, U.S. Army Research Laboratory, USA  
Bivas Mitra, Indian Institute of Technology Kharagpur, IN  
Maurice Mulvenna, University of Ulster, UK  
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**ICCAC 2016**  
International Conference on  
Cloud and Autonomic Computing

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# Messages from the Conference Chairs

## Message from the General Chair

Welcome to the 2016 IEEE International Conference on Cloud and Autonomic Computing (ICCAC) being held in Augsburg, Germany, on September 12-16, 2016. For the third time, ICCAC is co-located with the IEEE 10th International Conference on Self-Adaptive and Self-Organizing Systems (SASO) conference.

As General Chair, I had the pleasure to work with many people in the conference organization and steering committee who made this event possible. Special thanks go to Program Committee co-chairs Drs. Indranil Gupta ("Indy") and Yixin Diao as well as Workshop/Tutorial and Posters chairs Drs. Sameh Elnikety and Daniel Krutz respectively. Also, special thanks go to all members of the Program Committee for their hard work in putting together a high-caliber program. I would also like to extend thanks to the Web Chair Daniel Krutz, Publicity Committee co-chaired by Youssif Al-Nashif and Yaser Jaraweh, and our Proceedings Chair Cihan Tunc. Two members of ICCAC's steering committee, Manish Parashar and Salim Hariri, provided me with instrumental advise at every step of the way.

I hope you enjoy the ICCAC presentations, discussions, and hallway conversations with your colleagues.

Naveen Sharma, Rochester Institute of Technology, USA

## Message from the Program Chairs

Welcome to the IEEE International Conference on Cloud and Autonomic Computing being held in Augsburg, Germany. As Co-chairs of the Technical Program Committee (TPC), we are delighted to introduce this year's technical program. This year's call for paper included a wide range of topics such as Autonomic Cloud Computing, Autonomics for Extreme Scales, Autonomic Computing Foundations, Design Methods, Software Engineering Practices and Processes, and Tools and Applications. The conference has become truly international in scope and drew submissions from large number of countries. The members of the program committee were also drawn from 11 countries.

After a rigorous review process that involved at least three reviews for each paper followed by discussions at a virtual PC meeting, the committee accepted 10 full papers and 6 short papers, giving an acceptance rate below 25% for full papers. We are extremely grateful for the hard work, the insightful paper reviews, and thoughtful discussions by TPC members.

We would like to thank the conference steering committee and organizing committee as well as the publicity and proceedings chairs for their help in putting together the technical program. We would also like to extend our thanks to external reviewers who worked with the TPC in paper reviews.

Finally, we would like to thank all submitting authors for considering ICCAC as a venue for their work.

We hope you enjoy the technical program.

Indranil Gupta, University of Illinois at Urbana-Champaign, USA

Yixin Diao, IBM T. J. Watson Research Center, USA

# Sessions on Tuesday

## Session 1: Scheduling and Allocation

**Tuesday, September 13, 11:00 – 12:30  
1002T**

Chair: Naveen Sharma

Value of Service based Task Scheduling for Cloud Computing Systems  
Cihan Tunc  
Nirmal Kumbhare  
Ali Akoglu  
Salim Hariri  
Dylan Machovec  
Howard Jay Siegel

A Self-Adaptive Performance-Aware Capacity Controller in Overbooked Datacenters  
Seyed Saeid Masoumzadeh  
Helmut Hlavacs  
Luis Tomas

An Autonomous Network Aware VM Migration Strategy in Cloud Data Centres  
Martin Duggan  
Jim Duggan  
Enda Howley  
Enda Barrett

## Session 2: Data Management

**Tuesday, September 13, 14:00 – 15:30  
1002T**

Chair: Vladimir Vlassov

Automated Framework for Scalable Collection and Intelligent Analytics of Hacker IRC Information  
Jiakai Yu  
Cihan Tunc  
Salim Hariri

Autonomic Curation of Crowdsourced Knowledge: The Case of Career Data Management  
Alina Patelli  
Peter R. Lewis  
Hai Wang  
Ian Nabney  
David Bennett  
Ralph Lucas  
Alex Cole

Record Skipping in Parallel Data Processing Systems (short paper)  
Mareike Höger  
Odej Kao

An Autonomic Workflow Performance Manager for Weather Research and Forecast Modeling Workflows (short paper)  
Shuqing Gu  
Likai Yao  
Cihan Tunc  
Ali Akoglu  
Salim Hariri  
Elizabeth Ritchie

# Sessions on Tuesday

## Session 3: Storage and Small Business, and Other Short Papers

**Tuesday, September 13, 16:00 – 18:00**

*1002T*

Chair: Salim Hariri

OnlineElastMan: Self-Trained Proactive Elasticity Manager for Cloud-Based Storage Services

Ying Liu

Daharewa Gureya

Ahmad Al-Shishtawy

Vladimir Vlassov

Energy-Aware Adaptation in Managed Cassandra Datacenters

Emiliano Casalicchio

Lars Lundberg

Sogand Shirinbab

Four Steps To Get Ready For Cloud:  
A Roadmap For SMEs To Cloud Migration  
(short paper)

Nabeel Khan

An Investigation into SMEs Decision Making Process and Challenges Encountered During the Migration and Deployment of Cloud Computing Solutions (short paper)

Katie Wood

Evaluating the Performance of AppScale  
(short paper)

Philipp Ranft

Jan-Steffen Neurath

Jens Ehlers

Dynamic Allocation of Cloud Resources for Telecommunication Applications  
(short paper)

Oleg Vasilenko

# Sessions on Wednesday

## Session 4: System Management

**Wednesday, September 14, 11:00 – 12:30**

*1002T*

Chair: Yixin Diao

Autonomic Provisioning, Configuration, and Management of Inter-Cloud Environments  
Based on a Software Product Line Engineering Method

Alessandro Ferreira Leite

Vander Alves

Genaina Nunes Rodrigues

Claude Tadonki

Christine Eisenbeis

Alba Cristina Magalhaes Alves

de Melo

A Goal-Oriented Approach for Self-Configuring Mashup of Cloud Applications

Luca Sabatucci

Salvatore Lopes

Massimo Cossentino

An Intelligent Self-Management Framework for Optimized Availability of Cloud Services

Mamadou H. Diallo

Michael August

Roger Hallman

Megan Kline

Scott M. Slayback

Dylan Wolfe

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# FAS\*W 2016

## IEEE 1st International Workshops on Foundations and Applications of Self\* Systems

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# Message from the General Chairs

As General Chairs of the IEEE 10th International Conference on Self-Adaptive and Self-Organizing Systems (SASO) and the 2016 IEEE International Conference on Cloud and Autonomic Computing (ICCAC), we are happy to announce the IEEE 1st International Workshops on Foundations and Applications of Self\* Systems (FAS\*W) being held in Augsburg, Germany, on September 12-16, 2016.

FAS\*W is the successor to the very successful SASO workshops that accompanied the SASO conference since its very beginnings. With FAS\*W, SASO and ICCAC provide their community with a new platform that allows for leveraging synergy effects originating from the combined view on the research areas of self-adaptive and self-organizing systems as well as autonomic and cloud computing.

We are proud that the first edition of FAS\*W features 8 Workshops, 4 Tutorials, a Poster and Demo Session, as well as a Doctoral Symposium.

This would not have been possible without the help of the numerous people involved in the organization of FAS\*W and its events, as well as those that chose FAS\*W as the venue for their work. Many thanks for your support and contributions.

Finally, we hope that you enjoy the presentations, discussions, and hallway conversations with your colleagues, and wish you a pleasant and inspiring time in Augsburg.

**Wolfgang Reif**  
University of Augsburg, DE  
General Chair of SASO 2016

**Naveen Sharma**  
Rochester Institute of Technology, USA  
General Chair of ICCAC 2016

# Workshops

## 4th International Workshop on Autonomous Management of high performance Grid and Cloud Computing (AMGCC'16)

**Monday, September 12  
2001T**

### Scientific Organizers

Jaeyoung Choi, Soongsil University, KR  
Soonwook Hwang, Korea Institute of Science and Technology Information, KR

Grid computing leverages enormous computing resources scattered over the internet in order to integrate and form a large-scale computing platform to solve grand-scale problems. Grid computing also has had great influence on the cloud computing besides the virtualization technology, which logically decouples the physical computing resources with the computing system. Consequently, the cloud computing provides cost-effective, fast, and unlimited virtualized resources for large-scale applications. Cloud computing is also used as "utility computing" where the computing services are provided on-demand and as needs based. Thus, it is commonly deployed for various applications these days.

Managing hybrid, virtualized computing resources in a large-scale cloud computing environments, however, still leaves a lot of research to be conducted. Furthermore, autonomous managements of resources in such a large scale federated hybrid computing infrastructures are crucial. In this workshop, we would like to bring researcher around the world to discuss and communicate the challenges and research results in the design, implementation, and evaluation of novel autonomous hybrid cloud resource management systems, and the theory and practice of cloud and grid resource management.

## 3rd Edition of the IEEE Workshop on Quality Assurance for Self-adaptive, Self-organising Systems (QA4SASO)

**Monday, September 12  
2002T**

### Scientific Organizers

Benedikt Eberhardinger, University of Augsburg, DE  
Franz Wotawa, Technical University of Graz, AT  
Hella Seebach, University of Augsburg, DE

Developing self-adaptive, self-organising systems (SASO) that fulfil the requirements of different stakeholders is no simple matter. Quality assurance is required at each phase of the entire development process, starting from requirements elicitation, system architecture design, agent design, and finally in the implementation of the system. The quality of the artefacts from each development phase affects the rest of the system, since all parts are closely related to each other. Furthermore, the shift of adaption decisions from design-time to run-time – necessitated by the need of the systems to adapt to changing circumstances – makes it difficult, but even more essential, to assure high quality standards in these kind of systems. Accordingly, the analysis and evaluation of these self-\* systems has to take into account the specific operational context to achieve high quality standards. The necessity to investigate this field has already been recognized and addressed in different communities but there exists so far no platform to bring all these communities together. Therefore, the workshop provides within its third edition an established open stage for discussions about the different aspects of quality assurance for self-adaptive, self-organising systems.

# Workshops

## 2nd International Workshop on Data-driven Self-regulating Systems (DSS)

**Monday, September 12  
2003T**

### Scientific Organizers

Evangelos Pournaras, ETH Zurich, CH  
Akshay Uttama Nambi S.N., Delft University of Technology, NL  
Nik Bessis, Edge Hill University, UK

The emergence of pervasive and ubiquitous technologies together with social media has resulted in unprecedented opportunities to reason about the complexity of our society based on magnitudes of data. Embedded ICT technologies mandate the functionality and operations of several techno-socio-economic systems such as traffic systems, transportation systems, Smart Grids, power/gas/water networks, etc. It is estimated that over 50 billion connected smart devices will be online by the year 2020. Moreover, social media provide invaluable insights about the complexity of social interactions and how these interactions influence the sustainability of several ICT-enabled techno-socio-economic systems. These observations show that regulating online the complex systems of our nowadays digital society is a grand challenge. Regulation concerns trade-offs such as the alignment of technical requirements, e.g. robustness, fault-tolerance, safety and security, with social or environmental requirements, for instance, fairness in the utilization of energy resources. The scale of nowadays data cannot tackle the challenge by itself as data may convey ungrounded correlations and biased predictions. Smart, autonomic and selfregulating mechanisms are required for filtering data streams in real-time and transform them to valuable information based on which intelligent adaptive decisions can be made in a decentralized fashion under a plethora of operational scenarios.

## 1st eCAS Workshop on Engineering Collective Adaptive Systems (eCAS)

**Monday, September 12  
1003T**

### Scientific Organizers

Jacob Beal, Raytheon BBN Technologies, USA  
Nicola Capodieci, University of Modena and Reggio Emilia, IT

Collective Adaptive Systems (CAS) is a broad term that describes large scale systems that comprise of many units/nodes, each of which may have their own individual properties, objectives and actions. Decision-making in such a system is distributed and possibly highly dispersed, and interaction between the units may lead to the emergence of unexpected phenomena. CASs are open, in that nodes may enter or leave the collective at any time, and boundaries between CASs are fluid. The units can be highly heterogeneous (computers, robots, agents, devices, biological entities, etc.), each operating at different temporal and spatial scales, and having different (potentially conflicting) objectives and goals, even if often the system has a global goal that is pursued by means of collective actions. Our society increasingly depends on such systems, in which collections of heterogeneous 'technological nodes' are tightly entangled with human and social structures to form 'artificial societies'. Yet, to properly exploit them, we need to develop a deeper scientific understanding of the principles by which they operate, in order to better design them. This workshop solicits papers that address new methodologies, theories and principles that can be used in order to develop a better understanding of the fundamental factors underpinning the engineering and operation of such systems, so that we can better design, build, and analyse such systems.

# Workshops

## 9th International Workshop on Dynamic Software Product Lines. Variability at Runtime (DSPL)

**Friday, September 16  
2003T**

### Scientific Organizers

Jesper Andersson, Linnaeus University, SE  
Rafael Capilla, University Rey Juan Carlos, ES  
Holger Eichelberger, University of Hildesheim, DE

The concept of adaptation and self-adaptation of systems, in particular at runtime has caught the attention of the research community at large, both inside the domain of Software Product Lines (SPL) as well as outside SPL in areas like models-at-runtime, self-adaptive systems, ubiquitous computing, and specific application domains where runtime adaptation and post-deployment activities are required. Dynamic software product lines (DSPL) were established as a research area under the assumption that product line concepts can be very usefully applied in this context. Since its inception the DSPL-workshop addresses the mission of supporting adaptive and adaptable system development based on product line concepts. The lack of maturity and consolidation of DSPL approaches stills needs significant research effort to advance the state of the art. Our focus is to extend the community of researchers and to provide a forum for the discussion of current research on related topics.

## 4th International Workshop on Self-Adaptive and Self-Organising Socio-Technical Systems (SASO<sup>AST</sup>)

**Friday, September 16  
1003T**

### Scientific Organizers

Gerrit Anders, University of Augsburg, DE  
Jean Botev, University of Luxembourg, LU  
Markus Esch, FKIE, DE

The design and operation of computer systems has traditionally been driven by technical aspects and considerations. However, the usage characteristics of information and communication systems are both implicitly and explicitly determined by social interaction and the social graph of users. This aspect is becoming more and more evident with the increasing popularity of social network applications on the internet. This workshop will address all aspects of self-adaptive and self-organising mechanisms in socio-technical systems, covering different perspectives of this exciting research area ranging from normative and trust management systems to socio-inspired design strategies for distributed algorithms, collaboration platforms and communication protocols.

# Workshops

## 1st International Workshop on Self-Organising Construction (SOCO)

**Friday, September 16  
1005T**

### Scientific Organizers

Sebastian von Mammen, University of Augsburg, DE  
Ingo Mauser, Karlsruhe Institute of Technology, DE  
Heiko Hamann, University of Paderborn, DE

Our key theme is self-organising construction and we aim at cumulating, presenting, discussing and advancing new research results from theory and practice as well as novel scientific concepts and methodologies. Originally inspired by nest construction in social insects, the general concept relies on a large number of agents that coordinate their construction efforts by prompting and reacting to local stimuli. Very recently, with the wake of robotic swarms and novel material processing approaches, including for instance 3D printing techniques and innovative deployment of carbon fibres, self-organising construction is quickly gaining tremendous transformative significance in the context of various design and construction processes. These include also the construction, extension and renovation of architectural buildings, engineering design, industrial assembly and manufacture, and landscape architecture. Aligned with the host conference, we solicit for submissions that highlight the design and management of selforganising construction from a computational perspective.

## 1st International joint Workshops on Fog and Mobile Edge Computing, and on Information Security and Privacy for Mobile Cloud Computing, Web and Internet of Things (FMEC/ISCW-2016)

**Friday, September 16  
2002T**

### Scientific Organizers

Elhadj Benkhelifa, Staffordshire University, UK  
Yaser Jararweh, Jordan University of Science and Technology, JO  
B. B. Gupta, National Institute of Technology Kurukshetra, IN

Cloud computing provides large range of services and virtually unlimited available resources for users. New applications, such as virtual reality and smart building control, have emerged due to the large number of resources and services brought by cloud computing. However, the delay-sensitive applications face the problem of large latency, especially when several smart devices and objects are getting involved in human's life, such as the case of smart cities or Internet of Things. Therefore, cloud computing is unable to meet the requirements of low latency, location awareness, and mobility support. To solve this problem, researchers have introduced a trusted and dependable solution through the Fog and the Mobile Edge Computing to put the services and resources of the cloud closer to users, which facilitates the leveraging of available services and resources in the edge networks. By this, we are moving from the core (cloud data centers) to the edge of the network closer to the users. The aim of FMEC\ISCW-2016 is to provide a premier international platform for wide range of professions including scholars, researchers, academicians and Industry people to discuss and present the most recent security and privacy challenges and developments in Mobile Edge Computing, Mobile Cloud Computing, Web and Internet of Things' from the perspective of providing security awareness and its best practices for the real world.

# Tutorials

## Knowledge Level Models of Situations and Situation Assessment: Theory and Applications

**Monday, September 12, 9:30 – 12:30  
2004T**

Odd Erik Gundersen, Norwegian University of Science and Technology, NO

The concept of a situation is central to the situation management community. Still, the concept is not clearly defined and often research on the topic rarely refers to the definition of situation that the research is based on. The tutorial will present different definitions of the concept situation and complexities related to defining situation. Commonalities of the definitions will be discussed and formulated formally. The formal framework will be used to discuss situations that develop over time, observers of situations, future situations, the concept of history, explanations and justifications of predictions.

The three sub-processes of situation assessment are described by Mica Endsley's model of situation awareness. However, while the levels are given detailed descriptions, they are not related directly to any definition of the concept of a situation. By analyzing the concept of a situation in relation to the situation awareness levels, the situation awareness levels can be decomposed further into more fine-grained levels.

Context is an elusive concept as well. The tutorial will present some central definitions of context. These definitions will be discussed and analyzed in relation to the concepts situation and situation assessment. Furthermore, the role of context in situation assessment will be analyzed, and a context element ontology will be presented.

Examples of how the knowledge level model and the formal framework can be used to analyze domains will be given for use cases in oil well drilling and emergency services.

## Model-based Cloudification of Critical Applications

**Monday, September 12, 14:00 – 17:30  
2004T**

András Pataricza, Budapest University, HU  
Imre Kocsis, Budapest University, HU  
László Gönczy, Budapest University, HU

As more and more critical services are deployed in cloud-based environments, the design for dependability and performance over complex and partially uncontrolled platforms is becoming a key issue in several domains. The proposed tutorial aims at giving methodology and practical tools which help an end-to-end process for "cloudification" of applications and creating policies for the operation of such systems. We propose qualitative models which follow the engineers' way of thinking in system level assumptions and capture consequences of design decisions on system topology, deployment and characteristics of application level processes.

The method can be used for performance design (including measurement/benchmarking campaigns and SLA definition) and evaluation of deployment alternatives. Derivatives of high level models can be used runtime for monitoring and control, diagnosis purposes and proof of correctness of supervisory control as well.

The tutorial introduces qualitative modelling of IT system performance and dependability. Approaches for partial models reflecting individual aspects and validation – first-principles, engineering knowledge capture, synthesis from existing models, exploratory data analysis – are demonstrated. Hands-on model building will be performed using benchmark results of a distributed, soft-real time cloud application. Further hands-on activities show the application of the simulated model for evaluating dependability/performance test coverage, diagnosis and evaluating the effects of static and dynamic dependability mechanisms. Moreover, we present how the findings can be utilized as a solid basis for assuring self-\* properties.

## Context for adaptive Information Fusion

**Friday, September 16, 09:30 – 12:30  
2004T**

Lauro Snidaro, University of Udine, IT

Over the last few years, context-aware Information Fusion (IF) has gained increasing attention. Contextual Information (CI) can be understood as the information that "surrounds" an observable of interest, possibly influencing its state or even the sensing and estimation processes themselves.

The development of IF systems, to include data-, sensor-, and feature-level fusion, is a necessary engineering process in diverse applications, and new domains are more and more requiring an increasing degree of contextualized solutions and situation-adaptation mechanisms.

Typical advantages provided by the exploitation of CI include constrained estimates, refined inferences, and process adaptation.

Therefore, understanding and exploiting CI can be a key element for improving the performance of IF algorithms and automatic systems in general that have to deal with varying operating conditions.

Application examples include: context-aided surveillance systems (security/defence), traffic control, autonomous navigation, cyber security, ambient intelligence, ambient assistance, etc.

The purpose of this tutorial is to survey existing approaches for context-enhanced IF, covering the design and development of solutions integrating sensory data with contextual knowledge.

After discussing CI in other domains, the tutorial will focus on context representation and exploitation aspects for IF systems. The applicability of the presented approaches will be illustrated in fusion processes at different levels: from target tracking to situation assessment and reasoning.

Topics will include: Representation and exploitation of contextual information at different levels of an IF system; Managing of heterogeneous contextual sources; Adaptation techniques to have the system respond not only to changing target's state but also to the surrounding environment; Architectural issues and possible solutions; Augmentation of tracking and situation assessment algorithms with contextual information.

## Solving Soft Constraint Problems in Autonomic Systems with MiniBrass

**Friday, September 16, 14:00 – 17:30  
2004T**

Alexander Schiendorfer, University of Augsburg, DE

Combinatorial optimization problems (possibly NP-hard) present themselves in various facets of self-organizing and autonomic computing systems – in particular during the planning phase of the well-known MAPE loop. Examples thereof include resource allocation, role allocation, team formation, task scheduling/planning, or combinatorial auction. Desirable (or even valid) goal states adhere certain logical constraints. If not all goals can be achieved, developers are required to supply preference specifications to agents acting on their behalf. Instead of developing dedicated optimization algorithms for each of these problems, one can resort to constraint modeling languages and have the problem solved by efficient, highly-optimized solvers. In combination with user-friendly preference formalisms, this technology can be a valuable asset in the repertoire of researchers in autonomic systems. This tutorial provides an accessible, practical introduction to the field, exemplified by various models taken from the domain of self-organizing systems, in MiniBrass – a soft constraint library extension to the state-of-the-art constraint modeling language MiniZinc.

# Posters and Demos

## Posters and Demo

**Wednesday, September 14, 14:00 – 17:30**

*Lightning Talks in 1001T, Posters in Foyer*

### Poster

Smart Manufacturing and Reconfigurable Technologies: Towards an Integrated Environment for Evolvable Assembly Systems

David Sanderson  
Jack Chaplin  
Lavindra de Silva  
Paul Holmes  
Svetan Ratchev

A Dynamic Verification Mechanism for Real-time Self-Adaptive Systems

Hiroki Tsuda  
Hiroyuki Nakagawa  
Tatsuhiro Tsuchiya

ACE-JADE: Autonomic Computing Enabled JADE

Ali Farahani  
Eslam Nazemi  
Giacomo Cabri

Principle and Evaluation of a Self-Adaptive Multi-Agent System for State Estimation of Electrical Distribution Networks

Alexandre Perles  
Guy Camilleri  
Olivier Chilard  
Dominique Croteau  
Marie-Pierre Gleizes

Vascular Morphogenesis Controller:  
A Distributed Controller for Growing Artificial Structures

Payam Zahadat  
Daniel Hofstadler  
Thomas Schmickl

Combining Cost-Sensitive Classification with Machine Learning Algorithms for Cognitive

LTE Grant Forecasting

Jonathan Ah Sue  
Ralph Hasholzner  
Johannes Brendel  
Martin Kleinstreuber  
Jürgen Teich

In addition to the posters listed above, each ICCAC paper is accompanied by a poster presentation.

### Demo

Decentralized Coordination of Heterogeneous Ensembles using Jadex

Oliver Kosak  
Constantin Wanninger  
Andreas Angerer  
Alwin Hoffmann  
Andreas Schierl  
Hella Seebach

# Doctoral Symposium

The FAS\* Doctoral Symposium is an international forum for PhD Students working in the FAS\* research areas to subject their research to the scrutiny of external experts, gain experience in the presentation of research, connect with peers and experts addressing similar problems, and get advice from a panel of internationally leading researchers. This year's combined doctoral symposium of IEEE SASO and ICCAC includes four PhD student presentations, an invited talk, and a panel discussion.

## Session 1: Invited Talk & Panel Discussion

**Thursday, September 15, 14:00 – 15:30**  
1005T

### Invited Talk:

Surviving Life as a Researcher  
Jake Beal, BBN Technologies and MIT,  
USA

**Panel Discussion:** "Planning your PhD and Scientific Career"

## Session 2: Paper Presentations

**Thursday, September 15, 16:00 – 17:30**  
1005T

A Framework for Adaptive and Goal-Driven Behaviour Control of Multi-Robot Systems  
Christopher-Eyk Hrabia

Evolutionary Online Machine Learning from Imbalanced Data  
Anthony Stein

Unsupervised In-Silico Modeling of Complex Biological Systems  
John Kalantari

A Self-Adaptive Middleware for Attaining Semantic Self-Interoperation Property  
Kamaleddin Yaghoobirafai

The papers will also be presented as posters on Wednesday, September 14, 16:00 – 17:30 in Foyer.

# Organizational Remarks

## Important Addresses

### Conference Location

Universität Augsburg  
Hörsaalzentrum Physik  
Universitätsstraße 1  
86159 Augsburg

### Welcome Reception

Rathaus Augsburg  
Oberer Fletz  
Rathausplatz 2  
86150 Augsburg

### Conference Dinner

Parktheater im Kurhaus Göggingen  
Klausenberg 6  
86199 Augsburg

## Free Public Transport Ticket

Please note that the backside of your name badge serves as a free ticket for public transport for the whole conference week (zone 10 and 20). Please make sure you always have your name badge with you.

## Lunch

There is a whole bunch of possibilities for lunch next to the Hörsaalzentrum Physik. The easiest way is to have lunch at the university's dining hall. There you can pay cash at designated terminals. There are direction signs to the dining hall in front of the Physik Hörsaalzentrum; it is only a 2 minutes walk. In addition, there are several restaurants (American, Asian, Italien food), a supermarket, and a bakery if you leave the Hörsaalzentrum and turn to the right on the Universitätsstraße.

## WIFI Access

Free WIFI is available on the university campus. Vouchers with the corresponding login credentials are handed out at the registration desk.

## Registration and Information Desk

A registration and information desk is located at the foyer of the Physik Hörsaalzentrum. The desk opens at 8:00 and is open throughout the day. Here, you can always find somebody to help you with any kind of questions.



# Notes



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