APPLIED COMPUTING 2016

The 31st Annual ACM Symposium on Applied Computing
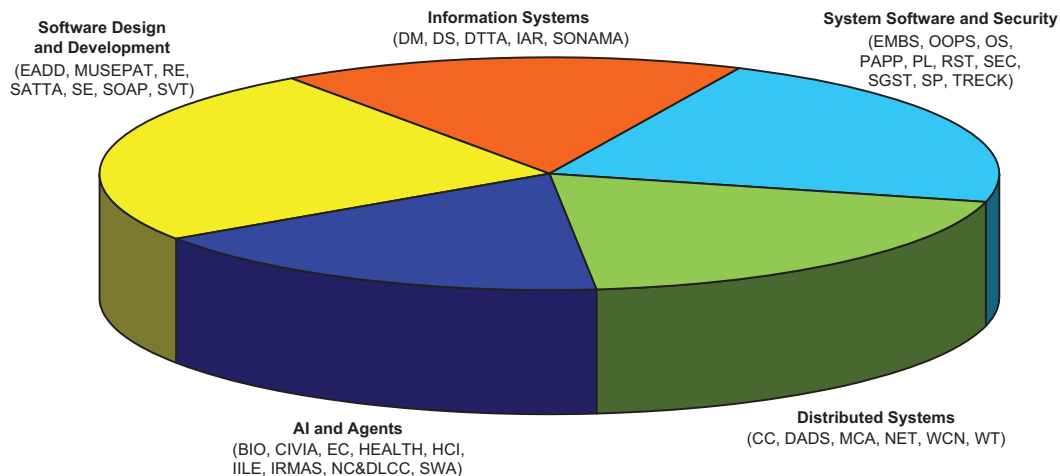
PROCEEDINGS OF THE 2016 ACM
SYMPOSIUM ON APPLIED COMPUTING

Pisa, Italy
April 4-8, 2016
Organizing Committee

Alessio Bechini
Giorgio Buttazzo
Hisham M. Haddad
Jiman Hong
Chih-Cheng Hung
John Kim

Maria Lencastre
Francesco Marcelloni
Sascha Ossowski
Ettore Ricciardi
Hossain Shahriar

Software Design and Development
(EADD, MUSEPAT, RE, SATTA, SE, SOAP, SVT)

Information Systems
(DM, DS, DTTA, IAR, SONAMA)

System Software and Security
(EMBS, OOPS, OS, PAPP, PL, RST, SEC, SGST, SP, TRECK)

AI and Agents
(BIO, CIVIA, EC, HEALTH, HCI, IILE, IRMAS, NC&DLCC, SWA)

Distributed Systems
(CC, DADS, MCA, NET, WCN, WT)

Hosted by
University of Pisa and Scuola Superiore Sant'Anna

The Association for Computing Machinery, Inc.

2 Penn Plaza, Suite 701
New York, New York 10121

Additional copies may be ordered prepaid from:

ACM Order Department
P.O. BOX 11405
Church Street Station
New York, NY 10286-1405
E-mail: acmhelp@acm.org

U.S.A. and Canada
Phone: 1-800-342-6626
All other countries
Phone: +1-212-626-0500
Fax: +1-212-944-1318

Printed in the U.S.A.

The 31st Annual ACM Symposium on Applied Computing

Pisa, Italy
April 4-8, 2016

CONFERENCE CHAIR
Sascha Ossowski, University Rey Juan Carlos, Spain

CONFERENCE VICE-CHAIRS
Giorgio Buttazzo, Scuola Superiore Sant'Anna, Italy
Alessio Bechini, University of Pisa, Italy

PROGRAM CHAIRS
Jiman Hong, Soongsil University, South Korea
Maria Lencastre, University of Pernambuco, Brazil

POSTERS CHAIR
Chih-Cheng Hung, Kennesaw State University, United States

PUBLICATION CHAIR
John Kim, Utica College, United States

TUTORIALS CHAIR
Francesco Marcelloni, University of Pisa, Italy

STUDENT RESEARCH COMPETITION CHAIR
Hossain Shahriar, Kennesaw State University, United States

LOCAL ARRANGEMENT CHAIR
Ettore Ricciardi, ISTI-CNR, Italy

TREASURER, REGISTRAR, & WEBMASTER
Hisham M. Haddad, Kennesaw State University, United States

About the Sponsoring SIG

ACM SIGAPP

The ACM Special Interest Group on Applied Computing is ACM's primary applications-oriented SIG. Its mission is to further the interests of the computing professionals engaged in the development of new computing applications and applications areas and the transfer of computing technology to new problem domains. SIGAPP offers practitioners and researchers the opportunity to share mutual interests in innovative application fields, technology transfer, experimental computing, strategic research, and the management of computing. SIGAPP also promotes widespread cooperation among business, government, and academic computing activities. Its annual Symposium on Applied Computing (SAC) provides an international forum for presentation of the results of strategic research and experimentation for this inter-disciplinary environment. SIGAPP membership fees are: $15.00 for ACM Non-members, $15.00 for ACM Professional Members, and $8.00 for ACM Student Members. For further information on SIGAPP, please contact Jiman Hong at jiman@ssu.ac.kr or visit the SIGAPP website at http://www.acm.org/sigapp.

Hosting Universities

SAC SRC Program Sponsor

Volume I: Artificial Intelligence and Agents, Distributed Systems, and Information Systems

Track Chairs

Theme: Artificial Intelligence and Agents

Computational Biology and Bioinformatics (BIO)

Paola Lecca, University of Trento, Italy
Dan Tulpan, National Research Council, Canada
Juan Manuel Corchado Rodriguez, University of Salamanca, Spain

Computational Intelligence and Video & Image Analysis (CIVIA)

Agostinho Rosa, University of Lisbon, Portugal
Yin-Fu Huang, National Yunlin University of Science and Technology, Taiwan

Evolutionary Computation (EC)

Raúl Giráldez, Pablo de Olavide University, Spain
Beatriz Pontes, University of Seville, Spain

Healthcare (HEALTH)

Cecilia Laschi, Scuola Superiore Sant'Anna, Italy
Arianna Menciassi, Scuola Superiore Sant'Anna, Italy

Smart Human Computer Interaction (HCI)

Soon Ki Jung, Kyungpook National University, South Korea
Anand Paul, Kyungpook National University, South Korea
Ganesh Kumar P., Anna University, India

Intelligent and Interactive Learning Environments (IILE)

Seiji Isotani, University of São Paulo, Brazil
Ig Ibert Bittencourt, Federal University of Alagoas, Brazil
Riichiro Mizoguchi, JAIST, Japan
Julita Vassileva, University of Saskatchewan, Canada

Intelligent Robotics and Multi-Agent Systems (IRMAS)

Rui P. Rocha, ISR - University of Coimbra, Portugal
Christopher D. Kiekintveld, University of Texas at El Paso, United State
M. Ani Hsieh, Drexel University, United States

Neuro Computing & Deep Learning and Continuous-Time Computing (NC&DLCC)

Sander Bohte, Centrum Wiskunde & Informatica, Netherlands
Davide Zambrano, Centrum Wiskunde & Informatica, Netherlands
Cecilia Laschi, Scuola Superiore Sant'Anna, Italy
Egidio Falotico, Scuola Superiore Sant'Anna, Italy
Florian Röhrbein, Technical University of Munich, Germany
Marc-Oliver Gewaltig, École Polytechnique Fédérale de Lausanne, Switzerland
Stefan Ulbrich, Technical University of Munich, Germany
Paul Levi, Technical University of Munich, Germany

The Semantic Web and Applications (SWA)

Soon Ae Chun, City University of New York, United States
Hyoil Han, Marshall University, United States
Sangsoo Sung, Google Inc., United States

Theme: Distributed Systems

Cloud Computing (CC)

Fernando De la Prieta, University of Salamanca, Spain
S.D Madhu Kumar, National Institute of Technology Calicut, India

Dependable and Adaptive Distributed Systems (DADS)

Karl M. Goeschka, UAS Technikum Vienna, Austria
Rui Oliveira, Universidade do Minho, Portugal
Peter Pietzuch, Imperial College London, United Kingdom
Giovanni Russello, University of Auckland, New Zealand

Mobile Computing and Applications (MCA)

Hong Va Leong, Hong Kong Polytechnic University, Hong Kong
Alvin Chan, Singapore Institute of Technology, Singapore

Networking (NET)

Mario M. Freire, University of Beira Interior, Portugal
Marilia Curado, University of Coimbra, Portugal
Manuela Pereira, University of Beira Interior, Portugal
Teresa Vazão, University of Lisboa, Portugal

Wireless Communications and Networking (WCN)

Dongkyun Kim, Kyungpook National University, South Korea
Wei Wang, San Diego State University, United States

Web Technologies (WT)

Angelo Di Iorio, University of Bologna, Italy
Davide Rossi, University of Bologna, Italy
Cristian Mateos, UNICEN University, Argentina

Theme: Information Systems

Data Mining (DM)

Hasan Jamil, University of Idaho, United States
Stefan Kramer, Johannes Gutenberg University - Mainz, Germany
Raymond Wong, University of New South Wales, Australia

Data Streams (DS)

Albert Bifet, Université Paris-Saclay, France
Pedro P. Rodrigues, Universidade do Porto, Portugal
João Gama, University of Porto, Portugal

Database Theory, Technology, and Applications (DTTA)

Ramzi A. Haraty, Lebanese American University, Lebanon
Apostolos N. Papadopoulos, Aristotle University, Greece
Junping Sun, Nova Southeastern University, United States

Information Access and Retrieval (IAR)

Gloria Bordogna, CNR IREA Consiglio Nazionale delle Ricerche, Italy
Gabriella Pasi, Università degli Studi di Milano Bicocca, Italy

Social Network and Media Analysis (SONAMA)

Sang-Wook Kim, Hanyang University, South Korea

Volume II: Software Design and Development, and System Software and Security

Track Chairs

Theme: Software Design and Development

Enterprise Application Development and Design (EADD)

Tomas Cerny, Czech Technical University in Prague, Czech Republic

Multicore Software Engineering, Performance, Applications, and Tools (MUSEPAT)

Tomas Vojnar, Brno University of Technology, Czech Republic

Requirement Engineering (RE)

Jaelson Castro, Universidade Federal de Pernambuco, Brazil
João Araújo, Universidade Nova de Lisboa, Portugal

Software Architecture: Theory, Technology, and Applications (SATTA)

Diego Perez-Palacin, Politecnico di Milano, Italy
Patrizia Scandurra, University of Bergamo, Italy

Software Engineering (SE)

Eunjee Song, Baylor University, United States
Byungjeong Lee, Univesity of Seoul, South Korea

Service-Oriented Architecture and Programming (SOAP)

Maurice ter Beek, ISTI-CNR, Italy
Hernán Melgratti, University of Buenos Aires, Argentina
Hugo Torres Vieira, IMT Lucca, Italy

Software Verification and Testing (SVT)

Mercedes G. Merayo, University Complutense of Madrid, Spain
Gwen Salaün, Grenoble INP, France

Theme: System Software and Security

Embedded Systems (EMBS)

Marco Di Natale, Scuola Superiore S. Anna, Italy
Li-Pin Chang, National Chiao-Tung University, Taiwan

Object Oriented Programming Languages and Systems (OOPS)

Davide Ancona, Universita` di Genova, Italy

Operating Systems (OS)

Bongjae Kim, Korea Electronics Technology Institute, South Korea
George Hamer, South Dakota State University, United States

Practical Aspects of High-Level Parallel Programming (PAPP)

Frédéric Loulergue, Université d'Orléans, France

Programming Languages (PL)

Marjan Mernik, University of Maribor, Slovenia
Barrett Bryant, University of North Texas, United States

Reliable Software Technologies and Communication Middleware (RST)

Marisol García-Valls, Universidad Carlos III de Madrid, Spain
Aniruddha Gokhale, Vanderbilt University, United States
Paolo Bellavista, Università di Bologna, Italy

Computer Security (SEC)

Giampaolo Bella, Università di Catania, Italy
Sergio Maffeis, Imperial College London, UK

Smart Grid and Smart Technologies (SGST)

Gail-Joon Ahn, Arizona State University, United States
Seong-Je Cho, Dankook University, South Korea
Dongwan Shin, New Mexico Tech, United States

Software Platforms (SP)

Jinman Jung, Hannam University, South Korea
Jun Huang, Chongqing University of Post & Telecommunications, China

Trust, Reputation, Evidence and other Collaboration Know-How (TRECK)

Ronald Petrlic, Saarland University, Germany
Jean-Marc Seigneur, University of Geneva, Switzerland

Message from the Symposium Chairs

Sascha Ossowski
Conference Chair

Giorgio Buttazzo
Conference Vice-Chair

Alessio Bechini
Conference Vice-Chair

On behalf of the Organizing Committee, we welcome you to the 31st Annual ACM Symposium on Applied Computing (SAC 2016), jointly hosted by University of Pisa and Scuola Superiore S. Anna, both in Pisa, Italy. For more than three decades this international forum has been dedicated to computer scientists, engineers, and practitioners for the purpose of presenting their research findings and results in various areas of applied computing. The organizing committee is grateful for your participation in this exciting international event. We hope that this conference proves interesting and beneficial for all of you. The Symposium on Applied Computing is sponsored by the ACM Special Interest Group on Applied Computing (SIGAPP), whose mission is to further the interests of computing professionals engaged in the design and development of new computing applications, interdisciplinary applications areas, and applied research. This conference is dedicated to the study of applied computing research of real-world problems. In addition, this event provides an avenue to discuss and exchange new ideas in the wide spectrum of applied computing areas. We all recognize the importance of updating the latest developments and research in our current areas of expertise.

SAC 2016 offers Technical Tracks and Poster Sessions. The success of the conference can be attributed to the substantial contribution of dedicated Track Chairs and Co-Chairs. Each track maintains a program committee and a set of highly qualified reviewers. We wish to thank the Track Chairs, Co-Chairs, Committee Members and participating reviewers for their hard work and effort to make SAC 2016 a high quality conference. We also thank our invited keynote speakers, Dr. John Mylopoulos (University of Toronto, Canada, and University of Trento, Italy) and Dr. Marco Conti (Institute of Informatics and Telematics, Italian National Council for Research, Pisa, Italy) for sharing their knowledge and expertise with SAC 2016 attendees. Most of all, we would like to especially thank the authors and presenters for sharing their experience with the rest of us, and all attendees for joining us in Pisa, Italy this year.

The local organizing committee has been a major contributor to the success of the SAC 2016 conference. Our gratitude goes to the Local Arrangement Chair Dr. Ettore Ricciardi, ISTI-CNR, Pisa, Italy. We extend our thanks to the Publication Chair, Dr. John Kim, Utica College, Utica, New York, USA, for his tremendous effort in putting together the conference proceedings, to the Posters Chair, Dr. Chih-Cheng Hung, Kennesaw University, Marietta, Georgia, USA, for his hard work to make a successful Poster Program, and to the Tutorials Chair Dr. Francesco Marcelloni, University of Pisa, Pisa, Italy, for arranging an exciting set of Tutorials. A big "thank you" also goes to Dr. Hossain Shahriar, Kennesaw University, Marietta, Georgia, USA, for organising the Student Research Competition, as well as to Dr. Hisham Haddad, Kennesaw University, Marietta, Georgia, USA, for simultaneously playing the roles of treasurer, registrar and webmaster (and many more). Special thanks to our Program Co-Chairs: Dr. Jiman Hong, Soongsil University, Seoul, Korea, and Dr. Maria Lencastre, University of Pernambuco, Recife, Pernambuco, Brazil for coordinating and bringing together an excellent Technical Program.

Again, we welcome you to SAC 2016 in the beautiful city of Pisa, Italy. We hope you enjoy the SAC 2016 conference and your stay in Italy. Next year, we invite you to participate in SAC 2017 to be held in Marrakech, Morocco. The conference will be hosted jointly by the University of Quebec at Montreal, Canada, University Cadi Ayyad of Marrakech, Morocco, the National School in Engineering (EMI) in Rabat, Morocco, and the National School of Applied Sciences (ENSA) in Kenitra, Morocco.

Message from the Program Chairs

Jiman Hong
Soongsil University
Seoul, South Korea

Maria Lencastre
University of Pernambuco
Recife, Pernambuco, Brazil

Welcome to the 31st International Symposium on Applied Computing (SAC 2016). For the past 30 years, SAC has become a major international venue for computing researchers and applied practitioners to convene and share ideas on recent developments in a variety of applied areas of information technology. The success of SAC has been the consolidation of a wide range of applied areas into specialized modules called Tracks. Each of the Tracks is then organized and administered by experts in the respective areas by instituting program committees, carrying out blind reviews according to the ACM guidelines, and finally selecting the highly qualified papers for the Track. Since its inception eight years ago, the Poster Sessions at SAC have become a tradition, and this year again the Poster will be an integral part of the Technical Program at SAC 2016.

The open Call for Track Proposals and after prescreening the proposals, 37 Tracks were finally accepted for SAC 2016. The prescreening and selections were made based on the success of those Tracks in the previous SACs as well as targeting new and emerging areas. The Call for Papers for these Tracks attracted 1047 final paper submissions from 58 different countries. The submitted papers underwent the blind review process and 252 submissions were finally accepted as full papers for inclusion in the Conference Proceedings and presentation during the Symposium. The final acceptance rate for SAC 2016 is 24.07% for the overall track. In addition to the accepted full papers, 111 submissions that received high enough review scores were accepted as poster papers for the Posters program. The Student Research Competition (SRC) program, sponsored by Microsoft Research, is designed to provide graduate students the opportunity to meet and exchange ideas with researchers and practitioners in their areas of interest. 47 submissions received and finally 22 papers were accepted for the SRC program.

The Technical Program of SAC 2016 is made possible through the hard work of many people from the scientific community who have volunteered and committed many hours to make it a success. Much credit goes to all Track Chairs for making SAC 2016 Technical Sessions a huge success. Some of the popular Tracks had an unprecedented submissions and having three blind reviews for each paper was certainly a major challenge. Once again this year, we follow the previous years' tradition in organizing various tracks into five different themes. The Symposium Proceedings and the technical presentations are focused around these themes to form a series of related track sessions. On behalf of the entire SAC 2016 Organizing Committee, we congratulate all the authors for having their papers accepted in their respective Tracks, and we wish to thank all of those who made this year's technical program a great success. Specifically, we wish to thank the speakers, posters chair, track chairs, reviewers, technical program committee members, session chairs, presenters, and all the attendees. We also wish to convey our special thanks to the local organizing committee lead by Dr. Giorgio Buttazzo from Scuola Superiore Sant'Anna, Pisa, Italy, Dr. Alessio Bechini from Scuola Superiore Sant'Anna, Pisa, Italy, Dr. Francesco Marcelloni from University of Pisa, Pisa, Italy, and Dr. Ettore Ricciardi from ISTI-CNR, Pisa, Italy. We wish you all a pleasant stay in Pisa, hope you have a great time at SAC 2016, and you will have the opportunity to share and exchange your ideas and foster new collaborations. We would also like to take this opportunity to convey to you the news that the 32nd International Symposium on Applied Computing (SAC 2017) will be held in the historic city of Marrakech, Morocco, which was declared a UNESCO World Heritage Site. We hope to see you all at SAC 2017.

Keynote Presentation:
The Requirements Problem in Software Engineering

John Mylopoulos
University of Toronto
Toronto, Canada
jm@cs.toronto.edu

ABSTRACT

The requirements problem is the problem of deriving a specification consisting of functions and quality constraints that along with a set of domain assumptions satisfy a given set of requirements. We present several formulations of the requirements problem to account for changing requirements, adaptive software design and the next release problem. In each case, we discuss the tractability of algorithms that search spaces of alternatives to find Pareto-optimal solutions to the problem. This is joint work with many colleagues and students, including Roberto Sebastiani, Paolo Giorgini, Fatma Aydemir, Chi Mai Nguyen (UniTN), Neil Ernst (CMU), Alex Borgida (Rutgers) and Ivan Jureta (Namur).

BIOGRAPHY

Dr. John Mylopoulos holds a professor emeritus position at the Universities of Toronto and Trento. He earned a PhD degree from Princeton University in 1970 and joined the faculty of the Department of Computer Science at the University of Toronto the same year. His research interests include conceptual modelling, requirements engineering, data semantics and knowledge management. Mylopoulos is a fellow of the Association for the Advancement of Artificial Intelligence (AAAI) and the Royal Society of Canada (Academy of Applied Sciences). He has served as programme/general chair of international conferences in Artificial Intelligence, Databases and Software Engineering, including IJCAI (1991), Requirements Engineering (1997, 2011), and VLDB (2004). Mylopoulos is currently leading a project titled "Lucretius: Foundations for Software Evolution", funded by an advanced grant from the European Research Council.

Keynote Presentation:
From MANET to People-centric Computing and Communications

Marco Conti
Institute of Informatics and Telematics (IIT)
National Research Council (CNR)
Pisa, Italy
marco.conti@iit.cnr.it

ABSTRACT

In this talk, we first discuss the evolution of the multi-hop ad hoc networking paradigm from MANET to the emerging people-centric networking, where personal mobile devices link the cyber-world with the physical world. People-centric networking leads immediately to emerging localized communication and computing services that are tightly coupled with people and their devices (e.g., mobile data offloading, opportunistic computing, etc.). In the second part of the talk, we discuss how the human behavior (e.g., human social organization) and its cognitive constraints can affect computing and communications in the cyber-physical world. Specifically, we show how embedding models of human behavior into information dissemination protocols can optimize information diffusion.

BIOGRAPHY

Dr. Marco Conti is a Research Director of the Italian National Research Council (CNR) and, currently, he is the Director of the CNR Department of Engineering, ICT and Technologies for Energy and Transportation. He has published in journals and conference proceedings more than 350 research papers related to design, modelling, and experimentation of computer networks, future Internet, social networks and pervasive computing systems. He co-authored the books: "Metropolitan Area Networks (MANs): Architectures, Protocols and Performance Evaluation" (Springer 1997) and "Online Social Networks: Human Cognitive Constraints in Facebook and Twitter Personal Graphs" (Elsevier, 2015), and he is co-editor of the books: "Mobile Ad hoc networking: the cutting edge technologies," (IEEE-Wiley 2013), "Mobile Ad Hoc Networking" (IEEE-Wiley 2004), and Mobile Ad Hoc Networks: from Theory to Reality (Nova Science Publishers 2007). He is Editor-in-Chief of Elsevier *Computer Communications* journal and Associate Editor-in-Chief of Elsevier *Pervasive and Mobile Computing* journal. He received the best paper award at several conferences, including IFIP TC6 Networking 2011 and IEEE WoWMoM 2013. He served as TPC chair for several major conferences -- including IFIP Networking 2002, IEEE WoWMoM 2005, IEEE PerCom 2006, and ACM MobiHoc 2006 -- and he was general chair (among many others) for IEEE WoWMoM 2006, IEEE MASS 2007 and IEEE PerCom 2010. He is the founder of successful conference and workshop series, such as *ACM RealMAN, IEEE AOC, ACM MobiOpp, and IFIP/IEEE SustainIT*.

Tutorial Presentation:
Multimedia Information Retrieval on a Very Large Scale

Giuseppe Amator
ISTI-CNR
Pisa, Italy
giuseppe.amato@isti.cnr.it

Fabrizio Falchi
ISTI-CNR
Pisa, Italy
fabrizio.falchi@isti.cnr.it

Claudio Gennaro
ISTI-CNR
Pisa, Italy
claudio.gennaro@isti.cnr.it

ABSTRACT

The tutorial first gives an overview of the most popular and effective visual features for content based retrieval: global visual descriptors, local visual descriptors, and deep/CNN features. Then, it introduces techniques able execute feature based similarity retrieval very efficiently, in datasets containing hundred millions images, with limited computing and storage resources. Similarity search is a difficult task because efficient techniques to process database or text queries cannot be applied here. Therefore in the last decades researcher have investigated techniques for executing similarity search efficiently and in a scalable way. The tutorial introduces state of the art techniques for similarity searching, as for instance LSH and permutation based methods. Finally, the tutorial discusses how the above concepts can be put in practice using Open Source solutions. It introduces the OpenCV library, which offers various tools for image analysis and feature extraction. It also discusses how Lucene, an open source text retrieval engine, can be easily used to index and search for visual information.

BIOGRAPHY

Giuseppe Amato graduated in Computer Science at the University of Pisa, Italy, in 1992 and was awarded a PhD in Computer Science at the University of Dortmund, Germany, in 2002. His main research interests are content-based retrieval of multimedia documents, access methods for similarity search of multimedia documents. He has participated in several EC and national funded research actions in the area of multimedia information retrieval.

Fabrizio Falchi has a Ph.D. in Information Engineering from University of Pisa (Italy), and a Ph.D. in Informatics from Faculty of Informatics of Masaryk University of Brno (Czech Republic). He also received an M.B.A. from Scuola Superiore Sant'Anna in Pisa. His research interests include similarity search, distributed indexes, multimedia information retrieval, computer vision, peer-to-peer systems. He has participated in several EC and National research projects.

Claudio Gennaro received the "Laurea" degree in Electronic Engineering from the University of Pisa, Italy, in 1994 and Master Degree in Information Technology at CEFRIEL of Milan. He received PhD Degree in Computer Engineering and Automatica in 1999 from Politecnico di Milano. His main interests are: Access Structures for Multimedia Retrieval, Digital Libraries, Model of Metadata for Audio/Video. Claudio Gennaro has had considerable previous experience in participation of European projects.

Tutorial Presentation: Developing Next-Generation Embedded and Cyber-Physical Systems

Albert M. K. Cheng

University of Houston
Houston, USA
cheng@cs.uh.edu

ABSTRACT

The use of sophisticated digital systems to control complex physical components in real-time has grown at a rapid pace. These applications range from traditional stand-alone systems to highly-networked cyber-physical systems (CPS). There are several benefits of using the Functional Reactive Programming (FRP) paradigm over the imperative programming style found in languages such as C/C++ and Java for implementing embedded and real-time software: reducing bugs and avoiding synchronization primitives. Hence, FRP can potentially transform the way we implement next-generation embedded systems and CPS. However, accurate response time analysis of FRP-based controllers remains a largely unexplored problem. This tutorial introduces a framework for the accurate response time analysis and scheduling of FRP-implemented embedded controllers. Real-time resource partitioning (RP) divides hardware resources (processors, cores, and other components) into temporal partitions and allocates these partitions as virtual resources to application tasks, and it is a key enabling technology for virtualization and cloud computing. This tutorial describes ways to maintain the schedulability of real-time tasks as if they were scheduled on dedicated physical resources and increase the utilization of the physical resources. This tutorial covers: (1) embedded real-time systems and CPS; (2) FRP; (3) timing analysis; (4) formal verification techniques based on RTL; (5) Real-Time Virtual Resources; and (6) case studies.

BIOGRAPHY

Albert M. K. Cheng is Professor and former interim Associate Chair of the Computer Science Department at the University of Houston (UH). He is the founding Director of the UH Real-Time Systems Laboratory. He received the B.A. with Highest Honors in Computer Science, graduating Phi Beta Kappa at age 19, the M.S. in Computer Science with a minor in Electrical Engineering at age 21, and the Ph.D. in Computer Science at age 25, all from The University of Texas at Austin, where he held a GTE Foundation Doctoral Fellowship. He has served as a consultant for many organizations, including IBM and Shell, and was also a Visiting Professor in the Departments of Computer Science at Rice University and at the City University of Hong Kong. Dr. Cheng is the author/co-author of 210 refereed publications in leading journals and top-tier conferences, and has received numerous awards, including the U.S. National Science Foundation Research Initiation Award (now known as CAREER). He has been invited to present seminars, tutorials, panel positions, and keynotes at over 100 conferences, organizations, and universities. He is and has been on the technical program committees (including many program chair positions) of over 250 conferences, symposia, workshops, and editorial boards). Dr. Cheng is the Chair of the 1st Workshop on Declarative Programming for Real-Time and CPS (December 1, 2015) and the 1st CPSWeek Workshop on Declarative CPS (April 11, 2016). He is the author of the popular textbook titled Real-Time Systems: Scheduling, Analysis, and Verification (Wiley); a Senior Member of the IEEE; an Honorary Member of INSTICC; and a Fellow of the Institute of Physics. He is the recipient of the 2015 University of Houston's Lifetime Faculty Award for Mentoring Undergraduate Research for his "Exceptional efforts in demonstrating a lasting commitment to undergraduate research."

Tutorial Presentation:
Mining (Streams of) Networked Data

Michelangelo Ceci
University of Bari Aldo Moro
Bari, Italy
michelangelo.ceci@uniba.it

João Gama
LIAAD-INESC
Porto, Portugal
jgama@fep.up.pt

ABSTRACT

Networks have become ubiquitous in several social, economics and scientific fields, ranging from the Internet to social sciences, biology, epidemiology, geography, communication systems, finance and many others. For this reason, several data mining approaches, specifically designed for tackling predictive and descriptive tasks for network data, have been proposed. In this tutorial, from one side, we intend to introduce the various forms of autocorrelation in network data and present the challenges that they pose to traditional data mining algorithms. To this aim, we will discuss different approaches that allow us to consider network autocorrelation either explicitly (with new heuristics) or implicitly (leveraging collective and semi-supervised/transductive learning which exploit the smoothness assumption). From the other side, we aim to provide the audience with a survey and a comparison of different problems arising when facing with networked data that evolve over time. The challenges in mining high speed network streams, require new algorithms. In this tutorial, we will present algorithms based on different window models and sampling strategies for networked streaming data. We will present methods to track the evolution of communities, identifying major events in these communities. The tutorial will conclude with a review of some practical applications of the presented methods in the areas of functional genomics, sensor networks, social networks, telecommunications, CRM, etc.

BIOGRAPHY

Michelangelo Ceci received a "Laurea" degree from the University of Bari in 2001. In 2005 he received his Ph.D. degree in Computer Science from the same University. Currently, he is associate professor at the University of Bari. His main research interests are in data mining and machine learning from complex and networked data. He was a visiting researcher at the University of Bristol (U.K.) and at the JSI (SLO). He has published more than 140 papers in refereed journals and conferences. He is member of the editorial boards of: IJSNM, IJDSN, IJDATS and JAIS. He has been the program co-chair of five workshops, the organizing committee chair of SEBD 2007, member of the editorial committee of "Intelligenza Artificiale" and member of the guest editorial board of the ECMLPKDD 2014-2016 journal tracks. He is Co-Chair of DS 2016 and ECMLPKDD 2017.

João Gama received his Licenciado degree from the Fac. of Engineering of the University of Porto, Portugal. In 2000 he received his Ph.D. degree in Computer Science from the Faculty of Sciences of the same University. Currently, he is Associate Professor at the Faculty of Economy and senior researcher at LIAAD - INESC Porto. He authored more than 200 papers in areas of machine learning, data streams and adaptive learning systems. He is a member of the editorial board of international journals including ML, DMKD, TKDE, NGC, and IDA. He served as Co-chair of ECML 2005, DS 2009, ADMA09, IDA 2011, ECMPKDD 2015 and a series of Workshops on KDDS and Knowledge Discovery from Sensor Data with ACM SIGKDD. He is author of a recent book on Knowledge Discovery from Data Streams.

Tutorial Presentation: Secure and Reliable Mobile Applications: Challenges and Approaches

Hossain Shahriar
Kennesaw State University
Marietta, USA
hshahria@kennesaw.edu

ABSTRACT

An increasing number of mobile applications are being developed to meet various needs of end users including SMS messaging, social networking, and game playing. It has been estimated that the revenues from mobile applications are expected to rise globally from $68Bn in 2013 to $143Bn in 2016. Android has become the leading smartphone Operating System in the world and currently occupying more than 50% of the global market share of smartphone. Unfortunately, this emerging area is not free from security and reliability issues.

Many of developed mobile applications contain vulnerabilities that may be exploited to cause unwanted actions. Reports find that 92% of Android's top 500 popular applications are vulnerable to some extent of security or privacy risk. Malware on a smartphone can make a phone partially or fully unusable, cause unwanted billing, or steal contact information stored in a phonebook. Further, benign applications may contain vulnerabilities due to the lack of developer knowledge and malware applications can exploit the known vulnerabilities by providing malicious inputs. Android applications may suffer from resource leakage. Particularly, memory leak can occur when users navigate applications in devices though screen rotation and pressing of built-in buttons leading to the crash of applications.

This tutorial is intended to provide a basic overview of Android applications, malware engineering, classification of malware, and mitigation approaches. We also explore content leakage vulnerability that may lead to security breaches and memory leakage that may cause an application to crash. The tutorial consists of three major parts. In the first part, we provide an overview of built in security features of Android followed by a set of common malware types. We then provide an overview of recent development to combat against malware. In the second part, we introduce the content leakage vulnerability in android applications. We show examples of best programming practices to reduce the exposure of content leakage issue. In the third part, we address the memory leak issue. We discuss future research directions. The discussion would argue that existing tools can address the challenge for building reliable and secure applications partially.

BIOGRAPHY

Dr. Hossain Shahriar is currently an Assistant Professor of Information Technology Department at Kennesaw State University, Georgia, USA. His research interests include software, web and mobile application security, malware analysis, mitigation of vulnerabilities based on information theory, risk analysis based on metrics. Dr. Shahriar has published over 50 peer reviewed journals, conference papers and book chapters. He served as Program Chair in SIN 2016, Workshop Co-Chair in SIN 2015, Fast Abstract Chair in IEEE COMPSAC 2015, and PC member in international conferences such as ACM SAC, SIN, and COMPSAC. Dr. Shahriar is currently a member of the ACM, SIGAPP, and IEEE.

Tutorial Presentation: Development of Correct-by-Construction Functional Parallel Programs

Frédéric Loulergue
Université d'Orléans
Orléans, France
Frederic.Loulergue@univ-orleans.fr

ABSTRACT

With the current generalization of parallel architectures and increasing requirement of parallel computation arises the concern of applying formal methods, which allow specifications of parallel and distributed programs to be precisely stated and the conformance of an implementation to be verified using mathematical techniques. However, the complexity of parallel programs, compared to sequential ones, makes them more error-prone and difficult to verify. This calls for a strongly structured form of parallelism, which should not only be equipped with an abstraction or model that conceals much of the complexity of parallel computation, but also provides systematic way of developing such parallelism from specifications for practically nontrivial examples.

Program calculation is a kind of program transformation based on the theory of constructive algorithms. An efficient program is derived step-by-step through a sequence of transformations that preserve the meaning and hence the correctness. With suitable data-structures, program calculation can be used for writing parallel programs.

The SyDPaCC system is a set of libraries for the proof assistant Coq (http://coq.inria.fr) that allows to write naive (i.e. inefficient) functional programs then to transform them into efficient versions that could be automatically parallelized within the framework before being extracted from Coq to code in the functional language OCaml plus calls to the parallel functional programming library Bulk Synchronous Parallel ML. The tutorial is an introduction both to Coq (ACM Software System Award in 2013} and the SyDPaCC system for the systematic development of *correct and verified parallel programs*.

BIOGRAPHY

Frédéric Loulergue obtained his PhD in Computer Science from the University of Orléans in 2000 and his Habilitation in Computer Science from Université Paris Val-de-Marne in 2004. He is currently a full professor at Université d'Orléans. His research interests are the practical and formal aspects of the design, implementation and application, in particular to large-scale data-intensive software, of structured parallel programming languages and libraries. He co-organized the series of international workshop on High-Level Parallel Programming and Applications (HLPP) between 2003 and 2010 and is now a member of its steering committee. In 2004, he created the series of international workshops on Practical Aspects of High-Level Parallel Programming (PAPP), and he has (co)-organized several PAPP workshops since then. He is a member of the editorial board of Scalable Computing: Practice and Experience, and Technique et Science Informatiques. He is currently the head of the Logic Modelling and Verification (LMV) research team at LIFO.

Tutorial Presentation: Context in Recommender Systems

Yong Zheng
DePaul University
Chicago, USA
yzheng8@cs.depaul.edu

ABSTRACT

Recommender system (RS) is able to alleviate the information overload problem and assist user's decision makings by recommending appropriate information to the end users. It has been widely applied in several applications, such as Amazon.com, Facebook, Netflix, etc. Context-aware recommender system (CARS) is a novel type of RS trying to adapt their recommendations to users' specific contextual situations, such as time and location. Accordingly, recommendation algorithms in CARS additionally take contexts into consideration, in contrast to the traditional recommendation approaches. Researchers believe that recommendations cannot stand alone without considering contexts, since users' preferences are always changing from contexts to contexts. For example, you may choose a romantic movie to watch with partner, but probably a cartoon if you are going to watch with kids.

There are two typical recommendation tasks involved when context is taken into account in RS: one is context-aware recommendation (CAR) and another one is context recommendation (CR). The basic research problems and challenges in CAR include context identification and selection, context incorporation and adaptation, context evaluation and interpretation, where CAR aims to recommend items to users by adapting to contextual information, e.g., which movies are appropriate to be recommended for John to watch *with his girlfriend*? By contrast, CR is a novel research direction emerged recently, and it will help suggest appropriate contexts for the users to consume the item to maximize user experience, e.g., which could be the best contexts (e.g., time, location, companion, emotional state, etc) for John to watch the movie "Titanic"?

In this half-day tutorial, the background and corresponding algorithms in recommender systems will be given at the beginning as the preliminary introduction. Afterwards, a comprehensive overview on those two recommendation tasks - CAR and CR, will be introduced to the audience. In addition, an open-source context-aware recommendation library, named as CARSKit, will also be introduced in order to show the ease of configuring and evaluating context-aware recommendation algorithms by this toolkit. By the end, we will further discuss the research problems and challenges in context recommendation.

BIOGRAPHY

Yong Zheng got his B.S. and M.S. degree in computer science in China, and he will obtain his PhD degree from DePaul University in 2016. His research interests lie in multi-disciplinary areas, including artificial intelligence, data mining and machine learning, information retrieval and recommender systems, etc. Over the past few years, his research focused on recommender systems, especially the development of context-aware recommender systems. He has published more than 40 peer-reviewed publications in related academic conferences, journals and book chapters. In addition, he served program committee member and reviewer for several academic journals, such as ACM Transactions on Information Systems (TOIS), ACM Transactions on the Web (TWeb), User Modeling and User-Adapted Interaction (UMUAI), and well-recognized international conferences, such as WWW, ACM RecSys, ACM IUI, ACM SAC, UMAP, ICWSM, and so forth.

Tutorial Presentation: Towards the Internet of Relevant Things. The IEEE 802.15.4e Standard

Giuseppe Anastasi
University of Pisa
Pisa, Italy
domenico.deguglielmo@iet.unipi.it

Simone Brienza
University of Pisa
Pisa, Italy
simone.brienza@for.unipi.it

Domenico De Guglielmo
University of Pisa
Pisa, Italy
giuseppe.anastasi@unipi.it

ABSTRACT

The Internet of Things (IoT) will completely change the way we live and work. In near future, billions of smart objects will be connected to the Internet, paving the way for a large number of innovative services in different application domains including smart cities, smart buildings, factory automation, e-health, etc. In many of such domains, applications have stringent requirements in terms of communication reliability, timeliness, scalability, and energy efficiency. To address the needs of such critical applications, the IEEE has recently released the 802.15.4e amendment that extends the original 802.15.4-2006 standard. By combining time slotted access with multi-channel communication and frequency hopping, the new 802.15.4e MAC protocols can provide highly-reliable, time-bounded, and low-power communication. Also, they can easily support multi-hop mesh networks. This tutorial will present the opportunities offered by the new standard in the perspective of the Internet of Things. Specifically, it will start with a description of the IEEE 802.15.4 standard to highlight the main reasons that limit its adoption in critical scenarios. Then, the improvements introduced by 802.15.4e will be discussed, with focus on the main MAC protocols (i.e., TSCH, DSME). For each considered MAC protocol, a description of its specific features will be provided and potential application domains will be identified. The tutorial will also include a survey of the main research activities on 802.15.4e networks. Special attention will be devoted to issues arising from the integration of 802.15.4e within the IoT framework.

BIOGRAPHY

Giuseppe Anastasi is Full Professor and Associate Head at the Department of Information Engineering of the University of Pisa, Italy. He is also the director of the Smart Cities National Lab, supported by CINI (Italian University Consortium for Informatics). He directs the executive Master in Smart Cities, a post-graduate specialization program organized by the University of Pisa in cooperation with the Italian National Research Council (CNR). His scientific interests include Distributed and P2P Systems, Internet of Things, Pervasive Computing, Sustainable Computing, and ICT for Smart Cities. He has published about 130 research papers in the area of computer networking and pervasive computing, gathering more than 4500 citations. Dr. Anastasi is Associate Editor of Sustainable Computing (SUSCOM) and Area Editor of Pervasive and Mobile Computing (PMC). He has been the co-founder of a number of successful international workshops and conferences. Currently, he is a member of the Board of Directors of the Italian National University Consortium for Informatics (CINI). Dr. Anastasi received the M.Sc. degree in Electronics Engineering, and the Ph.D. degree in Computer Engineering, from the University of Pisa, in 1990 and 1995, respectively.

Simone Brienza received his B.S. and M.S. degrees in Computer Engineering from the University of Pisa, in 2008 and 2012, respectively. Currently, he is a Ph.d. candidate at the Department of Information Engineering of the University of Pisa. His research concerns IEEE 802.15.4 and 802.15.4e WSNs.

Domenico De Guglielmo is a Postdoctoral Researcher in the Department of Information Engineering at the University of Pisa. His research interests are in the field of WSNs and Internet of Things.