



CrossMark

Preface

We are pleased to present this special issue of Elsevier's *Procedia Computer Science*, which consists of the proceedings of the 20th International Conference on Knowledge - Based and Intelligent Information & Engineering Systems (KES2016) which was organised by KES International and held on September 5th to 7th, 2016 in York, United Kingdom.

Celebrating 20 years of KES conferences, KES2016 was the 20th event in a series of broad-spectrum intelligent systems conferences first held in Adelaide, Australia in 1997. The main aim of this KES conference series is to provide an internationally respected forum for the dissemination of research results and the discussion of issues relating to the theory, technologies and applications of intelligent information and knowledge-based systems.

This year, this truly international conference attracted a substantial number of researchers and practitioners from all over the world who submitted their papers to five general tracks and 28 special sessions on specific topics. Accepted and presented papers highlight the new trends and challenge of intelligent and knowledge-based systems. Each paper was peer reviewed by at least two members of the International Program Committee and International Reviewer Board. Out of a large number of submissions, more than 200 high-quality papers were accepted for oral presentation and publication in *Procedia Computer Science*, submitted for indexing in CPCi (ISI conferences), Engineering Index, and Scopus.

We would like to express our thanks to the Keynote Speakers - Professors Andreas Holzinger (Austria), Detlef Nauck (UK), Trevor Martin (UK), Itsuki Noda (Japan) and Takahashi Washio (Japan).

Our special thanks go to the Programme Co-chairs, General Track Chairs, all International Programme Committee members and reviewers for their valuable efforts in the review process which helped us to guarantee the highest quality of selected papers for the conference. We cordially thank the organisers and chairs of special sessions which make an essential contribution to the success of the conference.

Finally, we thank all the authors, presenters and delegates for their valuable contribution to making this a successful event.

We hope and intend that KES2016 makes a significant contribution to international collaboration and understanding which is essential to the furtherance of scientific excellence.

Prof Robert J. Howlett
Prof Lakhmi C. Jain
Prof Bogdan Gabrys
Dr Carlos Toro and
Prof Chee Peng Lim
Editors, KES2016 Proceedings

Organisation

HONORARY CHAIR

Prof Rossi Setchi, Cardiff University, Wales, UK

GENERAL CHAIRS

Prof Robert J. Howlett, Bournemouth University, UK

Prof Lakhmi C. Jain, University of Canberra, Australia and Bournemouth University, UK

Prof Bogdan Gabrys, Bournemouth University, UK

PROGRAMME CHAIRS

General Track Programme Chair

Dr Carlos Toro, Vicomtech-IK4, SPAIN

Invited Sessions Programme Chair

Prof Chee Peng Lim, Deakin University, AUSTRALIA

KES LOCAL ORGANISING TEAM

Faye Alexander, KES International, UK

Peter Cushion, KES International, UK

Melanie Powell, KES International, UK

Shaun Lee, KES International, UK

KES CONFERENCE SERIES

KES2016 is part of the KES Conference Series

Conference Series Chairs:

L.C.Jain and **R.J.Howlett**

International Programme Committee

Name	Affiliation
Prof. Akinori Abe	Chiba University, Japan
Prof. Yoshinori Adachi	Chubu University, Japan
Dr. Alessia Amelio, Ph.D.	DIMES University of Calabria, Italy
Prof. Dr. Masayoshi Aritsugi	Kumamoto University, Japan
Dr. Piotr Artiemjew	University of Warmia and Mazury, Poland
Prof. Hajer Baazaoui	ISAMM - Riadi Laboratory , ENSI, University of Manouba
Prof. Valentina Emilia Balas	Aurel Vlaicu University of Arad, Romania
Prof. Zbigniew Banaszak	Warsaw Technical University, Warsaw, Poland
Dr. Francesco Bianconi	Department of Engineering, Università degli Studi di Perugia, Italy
Prof. Isabelle Bichindaritz	State University of New York at Oswego, USA
Dr. Gloria Bordogna	CNR IREA, Italy
Dr. Janos Botzheim	Tokyo Metropolitan University, Japan
Assist. Prof. Darko Brodić, Ph.D.	University of Belgrade, Technical Faculty in Bor
Prof. Alfonso Mateos Caballero	Universidad Politécnica de Madrid, Spain
Assoc. Prof. Frantisek Capkovic	Institute of Informatics, Slovak Academy of Sciences, Slovakia
Prof. Andre C P L F de Carvalho	Universidade de Sao Paulo, Brazil
Prof. Michele Ceccarelli	Qatar Computing Research Institute, HBKU
Prof. Krzysztof Cetnarowicz	AGH University of Science and Technology, Poland
Prof. Mu-Chen Chen	National Chiao Tung University, Taiwan
Prof. Stelvio Cimato	Dept. of Computer Science, Università degli studi di Milano, Italy
Dr. Paolo Crippa	Department of Information Engineering, Università Politecnica delle Marche, Italy
Prof. Alfredo Cuzzocrea	University of Trieste and ICAR-CNR, Italy
Prof. Ireneusz Czarnowski	Gdynia Maritime University, Poland
Prof. Margarita N. Favorskaya	Siberian State Aerospace University, Russian Federation
Prof. Colette Faucher	LSIS-Polytech'Marseille, France
Prof. Francisco Herrera	University of Granada, Spain
Dr. Yulia A Hicks	Cardiff University, UK
Dr. Muhammad Marwan Muhammad Fuad	University of Tromsø- Norway
Assoc. Prof. Otoniel Mario López Granado	Universidad Miguel Hernández, Spain
Dr. Ayman Hajja	The University of North Carolina at Charlotte, USA
Prof. Anne Hakansson	KTH Royal Institute of Technology, Sweden
Prof. Ronald Hartung	Franklin University, USA
Prof. Ioannis Hatzilygeroudis	University of Patras, Greece
Yuki Hayashi	Osaka Prefecture University, Japan
Prof. Atsuo Hazeyama	Tokyo Gakugei University, Japan
Dr. Dawn .E.Holmes	University of California, Santa Barbara, USA
Prof. Katsuhiro Honda	Osaka Prefecture University, Japan
Assoc. Prof. Dr. Daocheng Hong	Fudan University, China
Prof. Tzung-Pei Hong	National University of Kaohsiung, Taiwan
Prof. Wei-Chiang Hong	Nanjing Technology University, Nanjing China

Name	Affiliation
Prof. Xiangpei Hu	Dalian University of Technology, Dalian, China
Dr. Shraddha Ingale	Pune University, (M.S.) India
Prof. Nobuhiro Inuzuka	Nagoya Institute of Technology, Japan
Prof. Dr. Yoshiteru Ishida	Toyohashi University of Technology, Japan
Prof. Mirjana Ivanovic	University of Novi Sad, Serbia
Prof. Yuji Iwahori	Chubu University, Japan
Prof. Lakhmi C. Jain	University of South Australia, Australia
Prof. Ryszard Janicki	McMaster University, Hamilton, Canada
Prof. Reza Nakhaie Jazar	RMIT University, School of Aerospace, Mechanical & Manufacturing Engineering (SAMME), Melbourne, Australia
Prof. Piotr Jedrzejowicz	Gdynia Maritime University, Poland
Dr. Ivan Jordanov	University of Portsmouth, UK
Prof. Vladimir Jotsov	State University for Library Studies and Information Technologies, Bulgaria
Dr. Hideki Katagiri	Hiroshima University, Japan
Prof. Hideyuki Kanematsu	National Institute of Technology (NIT), Suzuka College, Japan
Dr. Hiroharu Kawanaka	Graduate School of Eng., Mie University, Japan
Prof. Frank Klawonn	Ostfalia University of Applied Sciences, Germany
Prof. Tomoko Kojiri	Kansai University, Japan
Prof. Beata Konikowska	Institute of Computer Science, Polish Academy of Sciences, Poland
Dr. Boris Kovalerchuk	Central Washington University, USA
Dr. Konrad Kułakowski	AGH UST, Kraków, Poland
Prof. Mario Kusek	University of Zagreb
Noriyuki Kushiro	Kyushu Institute of Technology, Japan
Prof. Kazuhiro Kuwabara	Ritsumeikan University, Japan
Prof. CP Lim	Deakin University, Australia
Prof. Chengjun Liu	New Jersey Institute of Technology, USA
Prof. Ignac Lovrek	University of Zagreb, Croatia
Prof. Minhua Ma	University of Huddersfield, UK
Dr. Cecilia Zanni-Merk	ICube Laboratory / INSA de Strasbourg, France
Assist. Prof. Hirokazu Miura	Wakayama University, Japan
Prof. Stefania Montani	University of Piemonte Orientale, Italy
Assoc. Prof. Motoki Miura	Kyushu Institute of Technology, Japan
Dr. Daniel Moldt	University of Hamburg, Department of Informatics, Germany
Dr. Esmiralda Moradian	Stockholm University, Sweden
Dr. Antonio Moreno	Univ. Rovira i Virgili (URV)
Prof. Mikhail Moshkov	KAUST, Saudi Arabia
Prof. Jun Munemori	Wakayama University, Japan
Prof. Tetsuya Murai	University of Hokkaido, Japan
Assist. Prof. Katsuko T. Nakahira	Nagaoka Institute of Technology, Japan
Prof. Grzegorz Nalepa	AGH University of Science and Technology, Poland
Prof. Kazunori Nishino	Kyushu Institute of Technology, Japan
Dr.-Ing. Joerg Rainer Noennig	TU Dresden, Laboratory of Knowledge Architecture, Germany

Name	Affiliation
Prof. Roy Oberhauser	Aalen University, Germany
Prof. Nobuyuki Ogawa	National Institute of Technology, Gifu College, Japan
Dr. Osvaldo Luiz Oliveira.	FACCAMP, Faculty Campo Limpo Paulista, Brazil
Prof. Kenta Oku	Ritsumeikan University, Japan
Prof. Yukio Ohsawa	The University of Tokyo, Japan
Prof. Marcin Paprzycki	Polish Academy of Sciences, Poland
Prof. Petra Pernert	Institute of Computer Vision and applied Computer Sciences, IBAI, Germany
Prof. Georg Peters	Munich University of Applied Sciences
Dr. Clara Pizzuti	Institute for High Performance Computing and Networking (ICAR) National Research Council of Italy (CNR)
Prof. Lech T. Polkowski,	Polish-Japanese Institute of IT, Poland
Prof. Luigi Portinale	University of Piemonte Orientale, Italy
Prof. Jim Prentzas	Democritus University of Thrace, Greece
Dr. Marina Resta	University of Genova, School of Social Sciences, Italy
Prof. Ana Respicio	University of Lisbon, Portugal
Dr. Goce Ristanoski	Data61, Australia
Prof. Marcello Sanguineti	University of Genova, Department of Computer Science, Bioengineering, Robotics, and Systems Engineering, Italy
Assoc. Prof. Masato Soga	Wakayama University, Japan
Dr. Jose Hiroki Saito	Federal University of Sao Carlos, Brazil
Assoc. Prof. Peter Sarlin	Hanken School of Economics and RiskLab, Finland
Prof. Juan Manuel Górriz-Sáez	University of Granada, Spain
Prof. Virgilijus Sakalauskas	Vilnius University, Department of Informatics
Dr. Rainer Schmidt	University of Rostock, Germany
Prof. Udo Seiffert	Fraunhofer-Institute IFF Magdeburg, Germany
Dr. Hirosato Seki	Osaka University, Japan
Dr. Milan Simic	RMIT University, School of Aerospace, Mechanical & Manufacturing Engineering (SAMME), Melbourne, Australia
Prof. Roman Słowiński	Poznan University of Technology, Poland
Prof. Andrzej Sluzek	Khalifa University, Abu Dhabi
Assoc. Prof. Masato Soga	Wakayama University, Japan
Assist. Prof. Roman Sperka	Silesian University in Opava, Czech Republic
Dr. Urszula Stanczyk	Silesian University of Technology, Poland
Prof. Toshiharu Sugawara	Waseda University, Japan
Assoc. Prof. Lijun Sun	Dalian University of Technology, Dalian, China
Dr. Nobuo Suzuki	KDDI Corporation, Japan
Assoc. Prof. Peter Sarlin	Hanken School of Economics / RiskLab Finland, Arcada, Helsinki, Finland
Prof. Edward Szczerbicki	University of Newcastle, Australia
Dr. Piotr Szczuko	Multimedia Systems Department, Gdańsk University of Technology, Poland
Prof. Eulalia Szmidt	Systems Research Institute Polish Academy of Sciences, Poland
Prof. Masakazu Takahashi	University of Yamaguchi, Japan

Name	Affiliation
Associate Prof. Dr. Haruhiko Takase	Mie University, Japan
Prof. Hirokazu Taki	Wakayama University, Japan
Mr. Dilhan J. Thilakarathne	VU University Amsterdam, The Netherlands
Dr. Carlos Toro	University of the Basque Country, Spain
Prof. Ljiljana Trajkovic	Simon Fraser University, Canada
Prof. Kazuhiko Tsuda	The University of TSUKUBA, Tokyo
Prof. Shusaku Tsumoto	Shimane University, Japan
Prof. Claudio Turchetti	Department of Information Engineering, Università Politecnica delle Marche, Italy
Prof. Jeffrey W. Tweedale	University of South Australia / DST Group, Australia
Dr. Angelina Tzacheva	University of North Carolina at Charlotte, USA
Prof. Eiji Uchino	Yamaguchi University, Japan
Prof. Taketoshi Ushiamo	Kyushu University, Japan
Prof. Junzo Watada	Waseda University, Japan
Prof. Toyohide Watanabe	Nagoya Industrial Science Research Institute, Japan
Prof. Yoshiyuki Yabuuchi	Shimonoseki City University, Japan
Prof. Katsutoshi Yada	Kansai University, Japan
Prof. Kuniaki Yajima	National Institute of Technology, Sendai College, Japan
Prof. Takahira Yamaguchi	Keio University, Japan
Prof. Dr. Shuichiro Yamamoto	Nagoya University, Japan
Assist. Prof. Ryosuke Yamanishi	Ritsumeikan University, Japan
Prof. Atsuko K. Yamazaki,	Faculty of Engineering, Shibaura Institute of Technology, Japan
Prof. Takaya Yuizono	Japan Advanced Institute Science and Technology, Japan
Dr. Gregory Zacharewicz	University of Bordeaux, France
Prof. Danuta Zakrzewska	Lodz University of Technology, Institute of Information Technology, Poland
Prof. Alfred Zimmermann	Reutlingen University, Germany
Dr. Sergey Zykov	National Research University – Higher School of Economics, Russia