

Studies in Computational Intelligence

Volume 689

Series editor

Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

The series “Studies in Computational Intelligence” (SCI) publishes new developments and advances in the various areas of computational intelligence—quickly and with a high quality. The intent is to cover the theory, applications, and design methods of computational intelligence, as embedded in the fields of engineering, computer science, physics and life sciences, as well as the methodologies behind them. The series contains monographs, lecture notes and edited volumes in computational intelligence spanning the areas of neural networks, connectionist systems, genetic algorithms, evolutionary computation, artificial intelligence, cellular automata, self-organizing systems, soft computing, fuzzy systems, and hybrid intelligent systems. Of particular value to both the contributors and the readership are the short publication timeframe and the world-wide distribution, which enable both wide and rapid dissemination of research output.

More information about this series at <http://www.springer.com/series/7092>

Chantal Cherifi · Hocine Cherifi
Márton Karsai · Mirco Musolesi
Editors

Complex Networks & Their Applications VI

Proceedings of Complex Networks 2017
(The Sixth International Conference
on Complex Networks and Their
Applications)

Editors

Chantal Cherifi
University of Lyon 2
Lyon
France

Márton Karsai
École Normale Supérieure de Lyon
Lyon
France

Hocine Cherifi
University of Burgundy
Dijon
France

Mirco Musolesi
University College London
London
UK

ISSN 1860-949X

ISSN 1860-9503 (electronic)

Studies in Computational Intelligence

ISBN 978-3-319-72149-1

ISBN 978-3-319-72150-7 (eBook)

<https://doi.org/10.1007/978-3-319-72150-7>

Library of Congress Control Number: 2017959919

© Springer International Publishing AG 2018

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The International Conference on Complex Networks and Their Applications has been initiated in 2011. The idea was to support the rise of the scientific community that studies the world through the lens of networks. Initiated as a single-track workshop, it has grown gradually to become one of the major international events in network science. Every year, it brings together researchers from a wide variety of scientific background ranging from economy, medicine, biology, sociology, computer science, physics and many others in order to review current state of the field and formulate new directions. The great diversity of its participants allows for crossfertilization between fundamental issues and innovative applications.

This volume of proceedings contains a selection of papers presented during the sixth edition, hosted by the University of Lyon 2 (France), from 29 November to 01 December 2017. It is organized into 15 sections reflecting the multiple aspects of complex network issues.

We received 345 submissions originating from more than 60 countries around the world. Each of them has been peer reviewed by three independent reviewers from our international programme committee in order to ensure high quality of contributed material as well as adherence to conference topics. After the review process, 103 papers were selected to be included in the proceedings.

Each edition of the conference represents a challenge that cannot be successfully achieved without the deep involvement of plenty of people, institutions and sponsors. We address sincere thanks to all of them for their support and to the University of Lyon for making us so welcome.

We are very grateful to our keynote speakers for their plenary lectures covering different areas of the conference. The talk of Alex Arenas (Universitat Rovirai Virgili, Spain) dealt with the identification of the most versatile nodes in highly multidimensional data. The presentation given by Santo Fortunato (Indiana University, USA) focused on the community structure in complex networks. Jennifer Neville (Purdue University, USA) gave a talk on ‘The impact of network structure on relational machine learning’ and Daniele Quercia (Nokia Bell Labs,

UK) presented a talk entitled ‘Good City Life’. The talk given by Frank Schweitzer (ETH Zurich, Switzerland) was about ‘Spreading influence in social networks: From link-centric to nodecentric models’ and Katharina A. Zweig (TU Kaiserslautern, Germany) covered The Network Analysis Literacy from a socio-informatics perspective. The challenges that they tackled in their talks are without a doubt one of the reasons for the success of COMPLEX NETWORKS 2017.

Two speakers gave very illuminating tutorials that drew many conference participants. These talks have been held on 28 November 2017. Ginestra Bianconi (Queen Mary University, UK) gave a lecture entitled ‘Network theory: The challenges that lies ahead’ and Francesco Bonchi (ISI Foundation, Italy) delivered a lecture on mining information propagation data.

We record our thanks to our fellow members of the Organizing Committee. Huijuan Wang (TU Delft, Netherlands) and Hamamache Kheddouci (Lyon 1, France), the poster chairs for arranging the poster sessions program and the editing the book of abstracts. Jinhu Lü, the tutorial chair for managing the tutorials. Bruno Gonçalves (New York University, USA), Carlo Piccardi (Politecnico di Milano, Italy) and Feng Xia (Dalian University of Technology, China), the publicity chairs for encouraging participation from, respectively, America, Europe and Asia. Great thanks to Eric Fleury, the sponsor chair who dedicated his precious time for securing financial support.

We extend our thanks to the Milan team (University of Milan, Italy): Sabrina Gaito, the publication chair, Matteo Zignani, the web chair and Christian Quadri, the submission chair for the incredible work they have done, in maintaining the website and the editing the proceedings and the book of abstract.

We would also like to record our appreciation for the work of the local Arrangement Committee at the University of Lyon 2, Lounes Bentaha, Chantal Cherifi and Jannik Laval in making all the excellent logistical arrangements for the conference.

We also acknowledge the important contributions of the DISP Lab and the Pole RTI members at Lyon 2 University, in particular, Yacine Ouzrout, Aicha Sekhari and Nejib Moalla. Their efforts made a great contribution to the success of the conference.

We are also indebted to our partners, Alessandro Fellegara, Alessandro Egro and their team (Tribe Communication) for their passion and patience in designing the visual identity of the Conference.

We would also like to express our deepest appreciation to all those who have helped us for the success of this meeting. Sincere thanks to the contributors, the success of the technical program would not be possible without their creativity. Finally, we would like to express our most sincere thanks to the Program Committee members for their huge efforts within very short time.

Last but not least, we would like to express our gratitude for the Springer Nature team for their editorial support throughout the publication process. We hope that

this volume makes a useful contribution to issues surrounding the fascinating world of complex networks and that you enjoy the papers as much as we enjoyed organizing the conference and putting this collection of papers together.

Lyon, France
November 2017

Chantal Cherifi
Hocine Cherifi
Márton Karsai
Mirco Musolesi

Organization & Committees

General Chair

Hocine Cherifi, University of Burgundy

Advisory Board

Raissa D’Souza, University of California, Davis

Sabrina Gaito, University of Milan

Ben Y. Zhao, University of Chicago

Program Co-Chairs

Chantal Cherifi, University of Lyon 2

Mirco Musolesi, University College London

Marton Karsai, ENS de Lyon

Poster Chairs

Hamamache Kheddouci, University of Lyon 1

Huijuan Wang, Delft University of Technology

Publicity Chair

Bruno Gonçalves, New York University

Feng Xia, Dalian University of Technology

Carlo Piccardi, Politecnico di Milano

Local Committee Chairs

Lounes Bentaha, University of Lyon 2

Chantal Cherifi, University of Lyon 2

Jannik Laval, University of Lyon 2

Publication Chair

Sabrina Gaito, University of Milan

Tutorial Chair

Jinhu Lü, Chinese Academy of Sciences

Sponsor Chair

Eric Fleury, ENS de Lyon

Submission Chair

Christian Quadri, University of Milan

Web Chair

Matteo Zignani, University of Milan

Program Committee

Sophie Achard, GIPSA-Lab—CNRS, France
 Masaki Aida, Tokio Metropolitan University, Japan
 Luca Maria Aiello, Nokia Bell Labs, UK
 Tatsuya Akutsu, Kyoto University, Japan
 Reka Albert, Pennsylvania State University, USA
 Antoine Allard, Centre de Recerca Matemàtica, Spain
 Eivind Almaas, Norwegian University of Science and Technology, Norway
 Claudio Altafini, Linköping University, Sweden
 Lucila Alvarez-Zuzek, Universidad Nacional de Mar del Plata, Argentina
 Fred Amblard, University Toulouse 1 Capitole, France
 Claudio Angione, Teesside University, UK
 Alberto Antonioni, Carlos III University of Madrid, Spain
 Nino Antulov-Fantulin, ETH Zurich, Switzerland
 Nuno Araujo, Universidade de Lisboa, Portugal
 Elsa Arcaute, University College London, UK
 Valerio Arnaboldi, IIT-CNR, Italy
 Tomaso Aste, University College London, UK
 Martin Atzmueller, Tilburg University, Netherlands
 Rodolfo Baggio, Bocconi University, Italy
 James Bagrow, University of Vermont, USA
 Sven Banisch, Max Planck Institute for Mathematics in the Sciences, Germany
 Yaneer Bar-Yam, New England Complex Systems Institute, USA
 Baruch Barzel, Bar-Ilan University, Israel
 Nikita Basov, St. Petersburg State University, Russia
 Gareth Baxter, University of Aveiro, Portugal
 Mariano Beguerisse, Diaz University of Oxford, UK
 Rosa M. Benito, Universidad Politecnica de Madrid (UPM), Spain
 Jacob Biamonte, University of Malta, Malta
 Ginestra Bianconi, Queen Mary University of London, UK
 Jeremy Blackburn, University of Alabama at Birmingham, USA
 Anthony Bonato, Ryerson University, Canada
 Pierre Borgnat, CNRS, Laboratoire de Physique ENS de Lyon, France
 Stefan Bornholdt, University of Bremen, Germany
 Dan Braha, NECSI, USA

Ulrik Brandes, University of Konstanz, Germany
Lidia A. Braunstein, Universidad Nacional de Mar del Plata, Argentina
Markus Brede, University of Southampton, UK
Marco Bressan, Sapienza University of Rome, Italy
Dirk Brockmann, Humboldt University, Germany
Piotr Bródka, Wrocław University of Science and Technology, Poland
Javier M. Buldu, Universidad Rey Juan Carlos and Center for Biomedical Technology, Spain
Raffaella Burioni, Università di Parma, Italy
Kanat Camlibel, University of Groningen, Netherlands
Carlo Vittorio Cannistraci, Technical University Dresden, Germany
Vincenza Carchiolo, Università di Catania, Italy
Alessio Cardillo Catalan, Institute of Human Paleoecology and Social Evolution (IPHES), Spain
Rui Carvalho, Durham University, UK
Giona Casiraghi, ETH Zurich, Switzerland
Remy Cazabet, UPMC—Paris, France
L. Elisa Celis, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland
Mario Chavez, Lena—CNRS, France
Kwang-Cheng, Chen University of South Florida, USA
Fu Lai Chung, Hong Kong Polytechnic University, Hong Kong
Richard Clegg, Queen Mary University of London, UK
Jack Cole, ARL (ret), USA
Giacomo Como, Lund University, Sweden
Luciano da F. Costa, University of Sao Paulo, Brazil
Emanuele Cozzo, University of Zaragoza, Spain
Regino Criado, Universidad Rey Juan Carlos, Spain
Mihai Cucuringu, University of Oxford and Alan Turing Institute, UK
Jörn Davidsen, University of Calgary, Canada
Bhaskar Dasgupta, University of Illinois at Chicago, USA
Fabrizio De Vico Fallani, Inria—ICM, France
Michela Del Vicario, IMT Institute for Advanced Studies, Italy
Jean-Charles Delvenne, University of Louvain, Belgium
José Devezas, INESC TEC and DEI-FEUP, Portugal
Jana Diesner, University of Illinois at Urbana-Champaign, USA
Louis J. Dubé, Université Laval, Canada
Jordi Duch, Universitat Rovira i Virgili, Spain
Marten During, Université de Luxembourg, Luxembourg
Mohammed El Hassouni, FSR-UMV, Morocco
Omodei Elisa, UNICEF, USA
Frank Emmert-Streib, Tampere University of Technology, Finland
Gunes Ercal, SIUE, USA
Ernesto Estrada, University of Strathclyde, UK
Tim Evans, Imperial College London, UK
Mauro Faccin, ICTEAM, Université Catholique de Louvain, Belgium

Giorgio Fagiolo, Sant'Anna School of Advanced Studies, Italy
Hocine Ficheri, ENS, France
Alessandro Flammini, Indiana University, USA
Eric Fleury, ENS Lyon/INRIA, France
Manuel Foerster, University of Hamburg, Germany
Mattia Frasca, University of Catania, Italy
Sabrina Gaito, University of Milan, Italy
José Manuel Galán, University of Burgos, Spain
Edoardo Gallo, University of Cambridge, UK
Yérali Gandica, Université de Namur, Belgium
Antonios Garas, ETH Zurich, Switzerland
Alvaro Garcia-Recuero, Queen Mary University of London, UK
Gourab Ghoshal, University of Rochester, USA
Silvia Giordano, SUPSI, Switzerland
James Gleeson, University of Limerick, Ireland
Kwang-Il Goh, Korea University, Korea
Sergio Gómez, Universitat Rovira i Virgili, Spain
Jesus Gomez-Gardenes, University of Zaragoza, Spain
Bruno Gonçalves, New York University, USA
Przemyslaw Grabowicz, Max Planck Institute for Software Systems, Germany
Steve Gregory, University of Bristol, UK
Thilo Gross, University of Bristol, UK
Jelena Grujic, Vrije Universiteit Brussel, Belgium
Jean-Loup Guillaume, L3i—Université de la Rochelle, France
Mehmet Gunes, University of Nevada, Reno, USA
Aric Hagberg, Los Alamos National Laboratory, USA
Edwin Hancock, University of York, UK
Chris Hankin, Imperial College London, UK
Jin-Kao Hao, University of Angers, France
Yukio Hayashi, Japan Advanced Institute of Science and Technology, Japan
Laurent Hébert-Dufresne, Santa Fe Institute, USA
Denis Helic, KTI, TU-Graz, Austria
Shaun Hendy, University of Auckland, New Zealand
Babak Heydari, Stevens Institute of Technology, USA
Desmond Higham, University of Strathclyde, UK
Philipp Hoevel, TU Berlin, Germany
Seok-Hee Hong, University of Sydney, Australia
Ulrich Hoppe, University Duisburg-Essen, Germany
Pan Hui, Hong Kong University of Science and Technology, Hong Kong
Yuichi Ikeda, Kyoto University, Japan
Gerardo Iñiguez, National Autonomous University of Mexico (UNAM), Mexico
Plamen Ivanov, Boston University and Harvard Medical School, USA
Mahdi Jalili, RMIT University, Australia
Marco Alberto Javarone, School of Computer Science, University of Hertfordshire, UK
Hawoong Jeong, Korea Advanced Institute of Science and Technology, Korea

Tao Jia, Southwest University, Chongqing, China
Di Jin, Tianjin University, China
Hang-Hyun Jo, Asia Pacific Center for Theoretical Physics, Korea
Nick Jones, Imperial College, USA
Bertrand Jouve, CNRS, France
Byungnam Kahng, Seoul National University, Korea
Rushed Kanawati, Université Paris 13, France
Márton Karsai, ENS de Lyon, France
Mehmet Kaya, Firat University, Turkey
Przemyslaw Kazienko, Wroclaw University of Technology, Poland
Dror Kenett, Boston University, USA
Yoed Kenett, University of Pennsylvania, USA
Khalidoun Khashanah, Stevens Institute of Technology, USA
Hamamache Kheddouci, Université Claude Bernard, France
Hyoungshick Kim, Sungkyunkwan University, Korea
Maksim Kitsak, Northeastern University, UK
Mikko Kivela, University of Oxford, UK
Peter Klimek, Medical University of Vienna, Austria
Nicolas Kourtellis, Telefonica Research, Spain
Danai Koutra, University of Michigan, USA
Jérôme Kunegis, University of Namur, Belgium
Valentina Kuskova, National Research University, Russia
Ryszard Kutner, University of Warsaw, Poland
Haewoon Kwak, Qatar Computing Research Institute, Qatar
Lucas Lacasa, Queen Mary University of London, UK
Renaud Lambiotte, University of Oxford, UK
Christine Largeron, Université de Lyon, France
Jennifer Larson, New York University, USA
Matthieu Latapy, CNRS, France
Stephen Law, University College London, USA
Anna T. Lawniczak, University of Guelph, Canada
Benedicte Le-Grand, Université Paris 1 Panthéon Sorbonne, France
Eric Leclercq, University of Burgundy, France
Sang Hoon Lee, Korea Institute for Advanced Study, Korea
Benedicte Le-Grand, Université Paris 1 Panthéon Sorbonne, France
Sune Lehmann, Technical University of Denmark, Denmark
Xiang Li, Fudan University, China
Nelly Litvak, University of Twente, Netherlands
Yang-Yu Liu, Harvard Medical School, USA
Alessandro Longheu, University of Catania, Italy
Jinhu Lu, Chinese Academy of Sciences, China
John C. S. Lui, The Chinese University of Hong Kong, Hong Kong
Matteo Magnani, Uppsala University, Sweden
Clemence Magnien, CNRS—UPMC Sorbonne Universités, France
Hernan Makse, City College of New York, USA

Giuseppe Mangioni, University of Catania, Italy
Madhav Marathe, Virginia Tech, USA
Andrea Marino, University of Pisa, Italy
Antonio Marques, King Juan Carlos University, Spain
Michael Mäs, University of Groningen, Netherlands
Cristina Masoller, Universitat Politècnica de Catalunya, Spain
Rossana Mastrandrea, IMT Institute of Advanced Studies, Italy
Naoki Masuda, University of Bristol, UK
Petr Matous, University of Sydney, Australia
Matúš Medo, UESTC Chengdu, China
Natarajan Meghanathan, Jackson State University, USA
Guy Melançon, Université de Bordeaux, France
Jörg Menche, Austrian Academy of Sciences, Austria
Jose Fernando Mendes, University of Aveiro, Portugal
Ronaldo Menezes, Florida Institute of Technology, USA
Radosław Michalski, Wrocław University of Science and Technology, Poland
Bivas Mitra, Indian Institute of Technology Kharagpur, India
Marija Mitrovic, Institute of Physics Belgrade, Serbia
Suzy Moat, University of Warwick, UK
Yamir Moreno, Universidad de Zaragoza, Spain
Sotiris Moschoyiannis, University of Surrey, UK
Igor Mozetič, Jozef Stefan Institute, Slovenia
Animesh Mukherjee, Indian Institute of Technology, Kharagpur, India
Tsuyoshi Murata, Tokyo Institute of Technology, Japan
Katarzyna Musiał, Bournemouth University, UK
Muaz Niazi, COMSTATS Institute of IT, Pakistan
Andrea Omicini, Università di Bologna, Italy
Gergely Palla, Eötvös University, Hungary
Pietro Panzarasa, Queen Mary University of London, UK
Fragkiskos Papadopoulos, Cyprus University of Technology, Cyprus
Symeon Papadopoulos, Information Technologies Institute, Greece
Michela Papandrea, SUPSI, Switzerland
Han Woo Park, YeungNam University, Korea
Juyong Park, Korea Advanced Institute of Science and Technology, Korea
Andrea Passarella, IIT-CNR, Italy
Leto Peel, Université Catholique de Louvain, Belgium
Tiago Peixoto, University of Bath, UK
Matjaz Perc, University of Maribor, Slovenia
Nicola Perra, University of Greenwich, UK
Giovanni Petri, ISI Foundation, Italy
Carlo Piccardi, Politecnico di Milano, Italy
Carlos Pineda, Universidad Nacional Autónoma de México, México
Sebastian Poledna, International Institute for Applied System Analysis, Austria
Chiara Poletto, INSERM UMR-S 1136, France
Victor Preciado, University of Pennsylvania, USA

Natasa Przulj, University College London, UK
Christian Quadri, University of Milan, Italy
Marco Quaggiotto, ISI Foundation, Italy
Walter Quattrociochi, Labss, Institute of Cognitive Sciences and Technologies, Italy
Jose J. Ramasco, IFISC (CSIC-UIB), Spain
Asha Rao, RMIT University, Australia
Felix Redd-Tsochas, University of Oxford, UK
Gesine Reinert, University of Oxford, UK
Pedro Ribeiro, Universidade do Porto, Portugal
Massimo Riccaboni, IMT Institute for Advanced Studies, Italy
Laura Ricci, University of Pisa, Italy
Luis E. C. Rocha, Karolinska Institutet, Sweden
Luis M. Rocha, Indiana University, USA
Francisco Rodrigues, University of São Paulo, USA
Henrik Ronellenfitsch, Massachusetts Institute of Technology, Brazil
Luca Rossi, University of Copenhagen, Denmark
Martin Rosvall, Umeå Univeristy, Sweden
Camille Roth, CNRS, France
Amir Rubin, Ben-Gurion University of the Negev, Israël
Marc Santolini, Northeastern University, USA
Francisco C. Santos, INESC-ID and Instituto Superior Técnico, and ATP group, Portugal
Jari Saramäki, Aalto University, Finland
Hiroki Sayama, Binghamton University, SUNY, USA
Antonio Scala, Institute for Complex Systems/Italian National Research Council, Italy
Maximilian Schich, The University of Texas at Dallas, USA
Grant Schoenebeck, University of Michigan, USA
Ingo Scholtes, ETH Zurich, Switzerland
Frank Schweitzer, ETH Zurich, Switzerland
Caterina Scoglio, Kansas State University, USA
Simone Severini, University College London, UK
Aneesh Sharma, Twitter Inc, USA
Rajesh Sharma, University of Tartu, Estonia
Tiago Simas, Univerity of Cambridge, UK
Filippo Simini, University of Bristol, UK
Anurag Singh, National Institute of Technology Delhi, India
Per Sebastian, Skardal Trinity College, USA
Michael Small, The University of Western Australia, Australia
Zbigniew Smoreda, Orange Labs, France
Chaoming Song, University of Miami, USA
Mauro Sozio, Télécom ParisTech, France
Jie Sun, Clarkson University, USA
Pål Sundsøy, Norges Bank Investment Management, Norway
Michael Szell, Hungarian Academy of Sciences, Hungary
Bosiljka Tadic, Jozef Stefan Institute, Slovenia
Lucia Tajoli, Politecnico di Milano, Italy

Kazuhiro Takemoto, Kyushu Institute of Technology, Japan
Frank Takes, Leiden University, Netherlands
Fabien Tarissan, CNRS—ENS Paris-Saclay, France
Dane Taylor, University of Buffalo, USA
Claudio Juan Tessone, University of Zurich, Switzerland
I-Hsien Ting, National University of Kaohsiung, Taiwan
Olivier Togni, Burgundy University, France
Ljiljana Trajkovic, Simon Fraser University, Canada
Jan Treur, Vrije Universiteit Amsterdam, Netherlands
Milena Tsvetkova, London School of Economics and Political Science, UK
Liubov Tupikina, Ecole Polytechnique, France
Stephen Uzzo, New York Hall of Science, USA
Sergi Valverde, University Pompeu Fabra, Spain
Piet Van Mieghem, Delft University of Technology, Netherlands
Balazs Vedres, Central European University, Hungary
Huijuan Wang, Delft University of Technology, Netherlands
Pinghui Wang Xi'an, Jiaotong University, China
Xiaofan Wang, Shanghai Jiao Tong University, China
Guanghui Wen, Southeast University, Nanjing, China
Richard Wilson, University of York, UK
Ernst Wit, University of Groningen, Netherlands
Feng Xia, Dalian University of Technology, China
Gang Yan, Tongji University, China
Wenwu Yu, Southeast University, China
Maryam Zamani, Eötvös University, Ungheria
Ivan Zelinka, VSB Technical University of Ostrava, Czech Republic
Zi-Ke Zhang, Hangzhou Normal University, China
Matteo Zignani, University of Milan, Italy
Antonio Zippo, CNR, Italy
Vinko Zlatić, Rudjer Boskovic Institute, Croatia

Contents

Part I Network Measures

A Comparison of Approaches to Computing Betweenness Centrality for Large Graphs	3
John Matta	
Cycle-Centrality in Economic and Biological Networks	14
Pierre-Louis Giscard and Richard C. Wilson	
A Game Theoretic Neighbourhood-Based Relevance Index	29
Giulia Cesari, Encarnación Algaba, Stefano Moretti and Juan A. Nepomuceno	
The Impact of Partially Missing Communities on the Reliability of Centrality Measures	41
Christoph Martin	
Consistent Estimation of Mixed Memberships with Successive Projections	53
Maxim Panov, Konstantin Slavnov and Roman Ushakov	
Reducing Pivots of Approximated Betweenness Computation by Hierarchically Clustering Complex Networks	65
Angelo Furno, Nour-Eddin El Faouzi, Rajesh Sharma and Eugenio Zimeo	
Power Network Equivalents: A Network Science Based K-Means Clustering Method Integrated with Silhouette Analysis	78
D. Sharma, K. Thulasiraman, D. Wu and J. N. Jiang	

Part II Link Analysis and Ranking

Newton's Gravitational Law for Link Prediction in Social Networks . . .	93
Akanda Wahid -Ul- Ashraf, Marcin Budka and Katarzyna Musial-Gabrys	

Efficient Outlier Detection in Hyperedge Streams Using MinHash and Locality-Sensitive Hashing	105
Stephen Ranshous, Mandar Chaudhary and Nagiza F. Samatova	
Layer-Wise Model Stacking for Link Prediction in Multilayer Networks. Case of Scientific Collaboration Networks	117
Gali-Ketema Mbogo, Alexander Visheratin and Stepan Rakitin	
Evolutionary Community Mining for Link Prediction in Dynamic Networks	127
Nazim Choudhury and Shahadat Uddin	
Rank Aggregation for Course Sequence Discovery	139
Mihai Cucuringu, Charles Z. Marshak, Dillon Montag and Puck Rombach	
Part III Community Structure	
Community-Based Feature Selection for Credit Card Default Prediction	153
Qiucheng Wang, Yanmei Hu and Jun Li	
Tracking Bitcoin Users Activity Using Community Detection on a Network of Weak Signals	166
Cazabet Remy, Baccour Rym and Latapy Matthieu	
Vertex Deduplication Based on String Similarity and Community Membership	178
Ryan McConville, Weiru Liu and Jun Hong	
Motif-Based Community Detection in Multiplex Networks	190
Clara Pizzuti and Annalisa Socievole	
Influence Spreading Model Used to Community Detection in Social Networks	202
Vesa Kuikka	
Behind the Communities, a Focus on the Sparse Part of a Network . . .	216
Mehdi Djellabi, Bertrand Jouve and Frederic Amblard	
Fluid Communities: A Competitive, Scalable and Diverse Community Detection Algorithm	229
Ferran Parés, Dario García Gasulla, Armand Vilalta, Jonatan Moreno, Eduard Ayguadé, Jesús Labarta, Ulises Cortés and Toyotaro Suzumura	
ANCA : Attributed Network Clustering Algorithm	241
Issam Falih, Nistor Grozavu, Rushed Kanawati and Younès Bennani	
A Community-Driven Graph Partitioning Method for Constraint-Based Causal Discovery	253
Mandar S. Chaudhary, Stephen Ranshous and Nagiza F. Samatova	

Clustering-Structure Representative Sampling from Graph Streams	265
Jianpeng Zhang, Kaijie Zhu, Yulong Pei, George Fletcher and Mykola Pechenizkiy	
COMSIM: A Bipartite Community Detection Algorithm Using Cycle and Node's Similarity	278
Raphael Tackx, Fabien Tarissan and Jean-Loup Guillaume	
Parallel Community Detection Methods for Sparse Complex Networks	290
Philippe Gagnon, Gilles Caporossi and Sylvain Perron	
Part IV Diffusion and Epidemics	
Information Diffusion in Complex Networks: The Active/Passive Conundrum	305
Letizia Milli, Giulio Rossetti, Dino Pedreschi and Fosca Giannotti	
An Opportunistic Network Approach Towards Disease Spreading	314
Sara Joneydi, Mohammad Khansari and Amin Kaveh	
Identifying Top-K Important Nodes Based on Probabilistic-Jumping Random Walk in Complex Networks	326
Hui Yu, Luyuan Chen, Xi Cao, Zun Liu and Yongjun Li	
Part V Dynamics on/of Networks	
Efficient Incremental Laplace Centrality Algorithm for Dynamic Networks	341
Rui Portocarrero Sarmento, Mário Cordeiro, Pavel Brazdil and João Gama	
Modeling Peer Influence in Time-Varying Networks	353
Matthias Wölbitsch, Simon Walk and Denis Helic	
Toward a Better Understanding of Emotional Dynamics on Facebook	365
Fabiana Zollo, Borut Sluban, Igor Mozetič and Walter Quattrociocchi	
Ranking in Dynamic Graphs Using Exponential Centrality	378
Eisha Nathan, James Fairbanks and David Bader	
A Nonlinear Dynamical Approach to the Interpretation of Microblogging Network Complexity	390
Andrey Dmitriev, Victor Dmitriev, Olga Tsukanova and Svetlana Maltseva	
Capturing the Dynamics of Hashtag-Communities	401
Philipp Lorenz, Frederik Wolf, Jonas Braun, Nataša Djurdjevac Conrad and Philipp Hövel	

A Semantic Continuity Based Analysis of Topic Lifecycle on Social Networks	414
Kuntal Dey, Saroj Kaushik, Kritika Garg and Ritvik Shrivastava	
Seed Selection for Information Cascade in Multilayer Networks	426
Fredrik Erlandsson, Piotr Bródka and Anton Borg	
Network Signatures of Success: Emulating Expert and Crowd Assessment in Science, Art, and Technology	437
Igor Zakhlebin and Emőke-Ágnes Horvát	
Part VI Motif Discovery	
Detection of Four-Node Motif in Complex Networks	453
Zhaolong Ning, Lei Liu, Shuo Yu and Feng Xia	
Assortative Mixture of English Parts of Speech	463
Timothy Leonard, Lutz Hamel, Noah M. Daniels and Natallia V. Katenka	
Contextual Subgraph Discovery with Mobility Models	477
Anes Bendimerad, Rémy Cazabet, Marc Plantevit and Céline Robardet	
Temporal Communication Motifs in Mobile Cohesive Groups	490
Matteo Zignani, Christian Quadri, Michela Del Vicario, Sabrina Gaito and Gian Paolo Rossi	
Detecting Motifs in Multiplex Corporate Networks	502
Frank W. Takes, Walter A. Kusters and Boyd Witte	
On Mining Temporal Patterns in Dynamic Graphs, and Other Unrelated Problems	516
Orestis Kostakis and Aristides Gionis	
Part VII Network Models	
A Generative Model for Sparse, Evolving Digraphs	531
Georgios Papoudakis, Philippe Preux and Martin Monperrus	
Studying the Structure of Some Networks Using Certain Topological Indices	543
Meryam Zeryouh, Mohamed El Marraki and Mohamed Essalih	
Spin Model of Two Random Walkers in Complex Networks	555
Wenshuo Guo, Juntao Wang and Kwok Yip Szeto	
A Logical Constraint-based Approach to Infer and Explore Diversity and Composition in Thresholded Boolean Automaton Networks	567
Quoc-Trung Vuong, Roselyne Chauvin, Sergiu Ivanov, Nicolas Glade and Laurent Trilling	

Part VIII Network Visualization

Visualization of Multichannel EEG Coherence Networks Based on Community Structure Analysis	583
Chengtao Ji, Natasha M. Maurits and Jos B. T. M. Roerdink	
On Multitree-Like Graph Layering	595
Radek Marik	

Part IX Resilience and Control

Lean Structural Network Resilience	609
Javier Villalba-Diez, Ilaria De Sanctis, Joaquín Ordieres-Meré and Filippo Emanuele Ciarapica	
Identification of Critical Habitat Corridor Patches by Cut Node Ranking	620
Gianni Fenu and Pier Luigi Pau	
On SDN Controller Placement to Achieve Robustness Against Targeted Attacks	633
Mohammed J. F. Alenazi	
Improving the Chilean Internet Robustness: Increase the Interdependencies or Change the Shape of the Country?	646
Ivana Bachmann and Javier Bustos-Jiménez	
Action-Based Model for Topologically Resilient Supply Networks	658
Viplove Arora and Mario Ventresca	
Nucleation of Social Groups: The Role of Centrality Inequality and Social Mobility	670
Yaniv Dover and Guy Kelman	
Epidemiological Study of Browser-Based Malware for University Network with Partially Observed Flow Data	680
Sindhura Jaladhanki, Natallia Katenka and Lisa DiPippo	
Attacking Unexplored Networks - The Probe-and-Attack Problem	692
Bryan H. Chong and Mario Ventresca	
Social Learning Against Data Falsification in Sensor Networks	704
Fernando Rosas and Kwang-Cheng Chen	

Part X Network Analysis

Locality-Based Graph Clustering of Spatially Embedded Time Series	719
Fabian Maschler, Fabian Geier, Bodo Bookhagen and Emmanuel Müller	

Soft Textual Cartography Based on Topic Modeling and Clustering of Irregular, Multivariate Marked Networks	731
Mattia Egloff and Raphaël Ceré	
Consistency and Trends of Technological Innovations: A Network Approach to the International Patent Classification Data	744
Yuan Gao, Zhen Zhu and Massimo Riccaboni	
Part XI Modeling Human Behavior	
Concept Networks in Learning and the Epistemic Support of Their Key Concepts	759
Ismo T. Koponen and Maija Nousiainen	
Network Analysis of Migration Patterns in the United States	770
Travis Goldade, Batyr Charyyev and Mehmet Hadi Gunes	
An Adaptive Computational Network Model for Multi-Emotional Social Interaction	784
Ramona Roller, Suzan Q. Blommestijn and Jan Treur	
On the Gender of Books: Author Gender Mixing in Book Communities	797
Doina Bucur	
Criticality as Key-Concept to Understand Social Norms' Dynamics in Networks	809
Daniele Vilone, Giulia Andrighetto and John Realpe-Gómez	
Promotion of Robust Cooperation Among Agents in Complex Networks by Enhanced Expectation-of-Cooperation Strategy	815
Tomoaki Otsuka and Toshiharu Sugawara	
Representing Emoji Usage Using Directed Networks: A Twitter Case Study	829
Halley Fede, Isaiah Herrera, S. M. Mahdi Seyednezhad and Ronaldo Menezes	
Assessing the Effects of Social Familiarity and Stance Similarity in Interaction Dynamics	843
Kuntal Dey, Ritvik Shrivastava, Saroj Kaushik and Vaibhav Mathur	
On the Social Influence in Human Behavior: Physical, Homophily, and Social Communities	856
Luca Luceri, Alberto Vancheri, Torsten Braun and Silvia Giordano	
Replicator Equation and the Evolution of Cooperation on Regular Communities	869
Daniele Cassese	

Modeling the Co-evolution of Committee Formation and Awareness Networks in Organizations	881
Alex T. Jones, Noah E. Friedkin and Ambuj K. Singh	
 Part XII Social Reputation, Influence and Trust	
The Topological Face of Recommendation	897
Erwan Le Merrer and Gilles Trédan	
Information Dissemination in Scale-Free Networks: Profusion Versus Scarcity	909
Laurent Brisson, Philippe Collard, Martine Collard and Erick Stattner	
Is This Movie a Milestone? Identification of the Most Influential Movies in the History of Cinema	921
Livio Bioglio and Ruggero G. Pensa	
Navigated Random Walks on Amazon Book Recommendation Network	935
Lei Hou, Kecheng Liu and Jianguo Liu	
Identifying Spreading Sources and Influential Nodes of Hot Events on Social Networks	946
Nan Zhou, Xiu-Xiu Zhan, Qiang Ma, Song Lin, Jun Zhang and Zi-Ke Zhang	
Methods for Influence Maximization in Dynamic Networks	955
Tsuyoshi Murata and Hokuto Koga	
Exploring the Twitterland of the Impact Investing Market	967
Petra Kralj Novak, Luisa De Amicis, Catherine Hughes and Igor Mozetič	
Introducing Credibility to Model News Spreading	980
V. Carchiolo, A. Longheu, M. Malgeri, G. Mangioni and M. Previti	
Competences Network Based on Interaction Data for Recommendation and Evaluation Aims	989
Soumaya Yahiaoui, Christophe Courtin, Pierre Maret and Laurent Tabourot	
Relational Patterns in Cross-Media Information Diffusion Networks	1002
Tobias Hecking, Laura Steinert, Victor H. Masias and H. Ulrich Hoppe	
Modeling Peer and External Influence in Online Social Networks: Case of 2013 Referendum in Croatia	1015
Matija Piškorec, Nino Antulov-Fantulin, Iva Miholić, Tomislav Šmuc and Mile Šikić	

Power in Network Structures Based on Simulations	1028
Natalia Meshcheryakova and Sergey Shvydun	

Part XIII Networks in Finance and Economics

Modeling Stock Survivability Resilience in Signed Temporal Networks: A Study from London Stock Exchange	1041
Junqing Tang, Layla Khoja and Hans Rudolf Heinemann	

On the Performance of Network Science Metrics as Long-Term Investment Strategies in Stock Markets	1053
Andre Leone, Marcello Tomasini, Younis Al Rozz and Ronaldo Menezes	

The Evolution of Japanese Business Networks in ASEAN Countries Since the 1960s	1065
Jean-Pascal Bassino, Pablo Jensen and Matteo Morini	

Analyses on the Authority Migration and Geographical Context in Progeny Networks	1076
Jun-Home Chen, Jyi-Shane Liu, Yu-Lieh Huang and Yi-Jia Lin	

Revealing Persistent Structure of International Trade by Nonnegative Matrix Factorization	1088
Chikara Mizokami and Takaaki Ohnishi	

Shock Propagation Through Customer-Supplier Relationships: An Application of the Stochastic Actor-Oriented Model	1100
Yoshiyuki Arata, Abhijit Chakraborty, Yoshi Fujiwara, Hiroyasu Inoue, Hazem Krichene and Masaaki Terai	

Multiplex Dynamics on the World Trade Web	1111
Daryl R. DeFord	

Evolution of the Global Risk Network Mean-Field Stability Point	1124
Xiang Niu, Alaa Moussawi, Noemi Derzsy, Xin Lin, Gyorgy Korniss and Boleslaw K. Szymanski	

Multiplex Financial Networks: Revealing the Level of Interconnectedness in the Banking System	1135
Alejandro de la Concha, Serafin Martinez-Jaramillo and Christian Carmona	

Mapping Organizations' Goals and Leanings in the Lobbyist Network in Banking and Finance	1149
Borut Sluban, Jasmina Smailović, Petra Kralj Novak, Igor Mozetič and Stefano Battiston	

Real Implications of Quantitative Easing in the Euro Area: A Complex-Network Perspective	1162
Chiara Perillo and Stefano Battiston	
United Nations General Assembly Vote Similarity Networks	1174
Rijul Magu and Gonzalo Mateos	
Graph Theoretical Approach to Bow-Tie Interbank Networks Reconstruction	1184
Valentina Y. Guleva and Klavdiya O. Bochenina	
Part XIV Urban Systems	
Water Distribution Network Clustering: Graph Partitioning or Spectral Algorithms?	1197
A. Di Nardo, M. Di Natale, C. Giudicianni, R. Greco and G. F. Santonastaso	
Fast Extraction Method of Functional Clusters from Large-Scale Spatial Networks Based on Transfer Learning	1210
Takayasu Fushimi, Kazumi Saito, Tetsuo Ikeda and Kazuhiro Kazama	
Generating Realistic Road Usage Information and Origin-Destination Data for Traffic Simulations: Augmenting Agent-Based Models with Network Techniques	1223
Christian Hofer, Georg Jäger and Manfred Füllsack	
Part XV Brain Networks	
δ-MAPS: From fMRI Data to Functional Brain Networks	1237
Ilias Fountalis, Constantine Dovrolis, Bistra Dilkina and Shella Keilholz	
Network Based fMRI Neuro-Feedback for Emotion Regulation; Proof-of-Concept	1250
Yael Jacob, Ayelet Or-Borichev, Gilan Jackont, Nitzan Lubianiker and Talma Hendler	
Simultaneous Matrix Diagonalization for Structural Brain Networks Classification	1261
Nikita Mokrov, Maxim Panov, Boris A. Gutman, Joshua I. Faskowitz, Neda Jahanshad and Paul M. Thompson	
Dynamic Generative Model of the Human Brain in Resting-State	1271
Dali Guo, Viplove Arora, Enrico Amico, Joaquín Goñi and Mario Ventresca	
Author Index	1285