Editors

Zbigniew Suraj
Chair of Computer Science
University of Rzeszow
Rzeszow
Poland

Ludwik Czaja
Institute of Informatics
University of Warsaw
and Vistula University
Warsaw
Poland

This two-volume book contains the papers selected for presentation at the Concurrency, Specification and Programming (CS&P) Workshop. It is taking place from 28th to 30th September 2015 in Rzeszow, the biggest city in southeastern Poland.

CS&P provides an international forum for exchanging scientific, research, and technological achievements in concurrency, programming, artificial intelligence, and related fields. In particular, major areas selected for CS&P 2015 include mathematical models of concurrency, data mining and applications, fuzzy computing, logic and probability in theory of computing, rough and granular computing, unconventional computing models. In addition, three plenary keynote talks were delivered.

The Workshop was initiated in the mid-1970s by computer scientists and mathematicians from Warsaw and Humboldt Universities, as Polish-German annual meetings. The first meeting in this series was named 1st Symposium on Mathematical Foundations of Computer Science and it took place in Warsaw from 12th to 19th September 1976. These meetings have been suspended for some years in the eighties until the beginning of ninetieths, and reactivated in 1992. Since then, the Workshop bears the name CS&P, when the first meeting after the break came into effect in Berlin. Now, it is being organized every even year by the Humboldt University of Berlin and every odd year by the University of Warsaw.

It should be mentioned that the CS&P meetings, initially purely bilateral, since 1992 have developed into events attended by participants from a number of various countries beside Poland and Germany. In 2003 the University of Information Technology and Management in Rzeszow, in 2004, the Fraunhofer Institut FIRST in Berlin, and in 2015, the University of Rzeszow joined the organizers as full members of the Committee and financial contributors. The present CS&P 2015 meeting will be hosting participants from the following countries: Canada, Germany, India, Italy, Poland, Russia, Saudi Arabia, Slovakia, Ukraine.

The CS&P 2015 is the twenty-fourth meeting after the break. It received 53 submissions that were carefully reviewed by Program Committee members or external reviewers. After a reviewing process, 49 papers were accepted for presentation at the workshop and publication in the CS&P 2015 proceedings. This book also contains three extended abstracts by the plenary keynote speakers.

It is truly a pleasure to thank all those people who contributed to preparation of this book. In particular, we would like to express our appreciation for the work of the CS&P 2015 Program Committee members and external reviewers who helped to assure the high standards of accepted papers. We would like to thank all the authors of CS&P 2015, without whose high-quality contributions it would not have been possible to organize the workshop. We are grateful to the Organizing Committee members for their involvement in all the organizational matters related to the CS&P 2015 as well as the creation and maintenance of the conference website. We wish to express our thanks to Mikhail Moshkov, Andrzej Skowron and Louchka Popova-Zeugmann for accepting to be plenary speakers at CS&P 2015. We greatly appreciate the financial support received...
from the University of Rzeszow, the University of Warsaw, and the Vistula University in Warsaw.

We hope that the CS&P 2015 workshop proceedings will serve as a valuable reference for researchers and developers in the field.

September 2015

Zbigniew Suraj
Ludwik Czaja
Organization

CS&P 2015 was organized by the Chair of Computer Science, the University of Rzeszow, Rzeszow, Poland, in cooperation with the Institute of Mathematics and the Institute of Informatics, the University of Warsaw, Warsaw, Poland, the Vistula University, Warsaw, Poland, the Warsaw Center of Mathematics and Computer Science, Warsaw, Poland, and the Institute of Informatics, the Humboldt University, Berlin, Germany.

CS&P 2015 Conference Committees

**Program Committee**

- Hans-Dieter Burkhard, Humboldt University, Berlin, Germany
- Ludwik Czaja, University of Warsaw, Warsaw, Poland and Vistula University, Warsaw, Poland
- Monika Heiner, Brandenburg University, Cottbus, Germany
- Anna Gomolinska, University of Bialystok, Bialystok, Poland
- Magdalena Kacprzak, Bialystok University of Technology, Bialystok, Poland
- Hung Son Nguyen, University of Warsaw, Warsaw, Poland
- Wojciech Penczek, Institute of Computer Science, PAS, Warsaw, Poland and University of Podlasie, Siedlce, Poland
- Lech Polkowski, University of Warmia and Mazury, Olsztyn, Poland
- Louchka Popova-Zeugmann, Humboldt University, Berlin, Germany
- Holger Schlingloff, Fraunhofer FIRST and Humboldt University, Berlin, Germany
- Serhat Seker, Vistula University, Warsaw, Poland
- Andrzei Skowron, University of Warsaw, Warsaw, Poland and Systems Research Institute, PAS, Warsaw, Poland
- Zbigniew Suraj, University of Rzeszow, Rzeszow, Poland
- Marcin Szczuka, University of Warsaw, Warsaw, Poland
- Matthias Werner, Technical University, Chemnitz, Germany
- Karsten Wolf, University of Rostock, Rostock, Germany

**Organizing Committee**

- Aneta Derkacz
- Katarzyna Garwol
- Piotr Grochowalski
- Piotr Lasek
- Lukasz Maciura
- Wieslaw Paja
- Krzysztof Pancerz
- Zbigniew Suraj
- Piotr Wasilewski
External Reviewers

- Michal Knapik
- Artur Meski
- Roman Redziejowski
- Anna Sawicka
- Bartlomiej Starosta
- Maciej Szreter
- Dominik Slezak
- Piotr Chrzastowski-Wachtel
# Table of Contents

Detecting Hazardous Events from Sequential Data with Multilayer Architectures  
*Karol Kurach, Krzysztof Pawlowski*  
1

Instance-Level Constraints in Density-Based Clustering  
*Piotr Lasek*  
11

Controlling Petri Net Behavior Using Time Constraints  
*Irina A. Lomazova, Louchka Popova-Zeugmann*  
19

Evaluation of Decision Table Decomposition Using Dynamic Programming Classifiers  
*Michał Mankowski, Tadeusz Luba, Cezary Jankowski*  
34

ExpTime Tableaux with Global Caching for Graded Propositional Dynamic Logic  
*Linh Anh Nguyen*  
44

Estimation and Feature Selection by Application of Knowledge Mined from Decision Rules Models  
*Wiesław Paja, Krzysztof Panczerz*  
57

Information Systems and Soft Sets  
*Zofia Machnicka, Marek Palasinski*  
69

An Approach for Resolving Conflicts in Automatic Medical Objects Classification  
*Przemysław W. Pardel, Jan G. Bazan, Jacek Zarychta, Stanisława Bazan-Socha*  
73

An Afficient Equivalence-Checking Algorithm for a Model of Programs with Commutative and Absorptive Statements  
*Vladislav Podymov*  
85

Betweenness, Łukasiewicz Rough Inclusions, Euclidean Representations in Information Systems, Hyper-granules, Conflict Resolution  
*Lech T. Polkowski*  
97

Fuzzy Systems of Logical Inference and Their Applications  
*Oleksandr Provotar*  
111

Enhanced Error Correction Algorithm for RBF Neural Networks  
*Paweł Rozyczki, Janusz Kolbusz*  
120

The Minimization Method of Boolean Functions in Polynomial Set-theoretical Format  
*Bohdan Rytsar*  
130
VI

The Handling of Missing Values in Medical Domains with Respect to Pattern Mining Algorithms ........................................... 147
Danilo Schmidt, Matthias Niemann, Gabriela Lindemann-von Trzebiatowski

Petri Net Models of Simple Rule-Based Systems for Programming Physarum Machines .................................................. 155
Andrew Schumann, Krzysztof Pancerz

Rough Sets Inspired Extension of Forward Inference Algorithm .............. 161
Roman Siminski, Alicja Wakalicz-Deja

Hybrid Planning by Combining SMT and Simulated Annealing ............ 173
Jaroslaw Skaruz, Artur Niewiadomski, Wojciech Penczek

Optimization of Backward Fuzzy Reasoning Based on Rule Knowledge ...... 177
Zbigniew Suraj, Piotr Grochowalski, Sibasis Bandyopadhyay

Inverted Fuzzy Implications in Backward Reasoning Without Yager Implication . 187
Zbigniew Suraj, Agnieszka Lasek

SMT-based Searching for $k$-quasi-optimal Runs in Weighted Timed Automata . 196
Bozena Wozna-Szczesniak, Agnieszka M. Zbrzezy, Andrzej Zbrzezy

Reduct Calculation and Discretization of Numeric Attributes in Sparse Decision Systems .................................................. 207
Wojciech Swieboda, Hung Son Nguyen

Exploiters-Based Knowledge Extraction in Object-Oriented Knowledge Representation ....................................................... 211
Dmytro Terletskyi

Space-Time Viewpoints for Concurrent Processes Represented by Relational Structures .................................................. 222
Irina Virbitskaite, Elena Bochenkova, Evgeny Erofeev

From Free Will Debate to Embodiment of Fuzzy Logic into Washing Machines: On Fuzzy and Rough Sets Approaches to Vagueness Modeling ...... 234
Piotr Wasilewski

Global Optimization of Exact Association Rules Relative to Length ........ 237
Beata Zielosko

Author Index ......................................................................... 248