This volume contains papers presented at the 13th International Conference on Rough Sets, Fuzzy Sets and Granular Computing (RSFDGrC) held during June 25–27, 2011, at the National Research University Higher School of Economics (NRU HSE) in Moscow, Russia. RSFDGrC is a series of scientific events spanning the last 15 years. It investigates the meeting points among the four major disciplines outlined in its title, with respect to both foundations and applications. In 2011, RSFDGrC was co-organized with the 4th International Conference on Pattern Recognition and Machine Intelligence (PReMI), providing a great opportunity for multi-faceted interaction between scientists and practitioners.

There were 83 paper submissions from over 20 countries. Each submission was reviewed by at least three Chairs or PC members. We accepted 34 regular papers (41%). In order to stimulate the exchange of research ideas, we also accepted 15 short papers. All 49 papers are distributed among 10 thematic sections of this volume. The conference program featured five invited talks given by Jiawei Han, Vladik Kreinovich, Guoyin Wang, Radim Belohlavek, and C.A. Murthy, as well as two tutorials given by Marcin Szczuka and Richard Jensen. Their corresponding papers and abstracts are gathered in the first two sections of this volume.

We would like to thank all authors and reviewers for their work and excellent contributions. We express our gratitude to Lotfi A. Zadeh, who suggested many talented scientists to serve as PC members. The success of the whole undertaking would be impossible without collaboration with the Chairs of PReMI-2011, as well as the Chairs of workshops co-organized with the main conference. We also acknowledge the following organizations and sponsoring institutions: National Research University Higher School of Economics (Moscow), Laboratoire Poncelet (UMI 2615 du CNRS, Moscow), International Rough Set Society, International Fuzzy Systems Association, Russian Foundation for Basic Research, ABBYY Software House, Yandex (Moscow), and Springer. Last but not least, we are grateful to all Chairs and organizers of RSFDGrC-2011, especially to Dmitry I. Ignatov, whose endless energy saved us in the most critical stages of conference preparation.

April 2011

Sergei O. Kuznetsov
Dominik Ślezak
Daryl H. Hepting
Boris G. Mirkin
Organization

**General Chair**
Boris G. Mirkin, Russia

**Conference Chair**
Sergei O. Kuznetsov, Russia

**Program Co-chairs**
Dominik Ślezak, Poland
Daryl H. Hepting, Canada

**Organizing Chair**
Dmitry I. Ignatov, Russia

**Tutorial Co-chairs**
Chris Cornelis, Belgium
Sanghamitra Bandyopadhyay, India

**Publicity Co-chairs**
Jimmy Huang, Canada
Wei-Zhi Wu, China

**Program Committee**

Alexey N. Averkin, Russia
Mohua Banerjee, India
Alan Barton, Canada
Ildar Batyrshyn, Russia
Mihir K. Chakraborty, India
Ashok Deshpande, India
Lipika Dey, India
Anna Gomolińska, Poland
Vladimir Gorodetsky, Russia
Aboul E. Hassanien, Egypt
Qinghua Hu, China
M. Gordon Hunter, Canada
Dmitry I. Ignatov, Russia
Masahiro Inuiguchi, Japan
Ryszard Janicki, Canada
Manish Joshi, India
Michihiro Kondo, Japan
Rudolf Kruse, Germany
Yasuo Kudo, Japan
Tianrui Li, China
Pawan Lingras, Canada
Ju-Sheng Mi, China
Michinori Nakata, Japan
Hung Son Nguyen, Poland
Sergey Nikolenko, Russia
Vilem Novak, Czech Republic
Witold Pedrycz, Canada
Georg Peters, Germany

Sheela Ramanna, Canada
Hiroshi Sakai, Japan
Gerald Schaefer, UK
Kun She, China
Qiang Shen, UK
Marek Sikora, Poland
Vasily Sinuk, Russia
Andrzej Skowron, Poland
Roman Słowiński, Poland
Jarosław Stepaniuk, Poland
Zbigniew Suraj, Poland
Piotr Synak, Poland
Andrzej Szalas, Poland
Marcin Szczuka, Poland
Noboru Takagi, Japan
Domenico Talia, Italy
Valery Tarasov, Russia
Alexander Tulupiev, Russia
Xizhao Wang, China
Junzo Watada, Japan
Yanping Xiang, China
JingTao Yao, Canada
Nadezhda Yarushkina, Russia
Alexander Yazenin, Russia
Alla Zaboleeva-Zotova, Russia
William Zhu, China
Leonid E. Zhukov, Russia
Wojciech Ziarko, Canada
### Additional Reviewers

- Andrzej Chmielewski, Poland
- Si Yuan Jing, China
- Sharmistha Mitra, India
- Vsevolod Oparin, Russia
- Yulia Orlova, Russia
- Herald S. Plesnevich, Russia
- Jonas Poelmans, Belgium
- Julia Preusse, Germany
- Georg Ruß, Germany
- Alexander Sirotkin, Russia
- Matthias Steinbrecher, Germany
- Rustam Tagiew, Germany
Table of Contents

Invited Papers

Construction and Analysis of Web-Based Computer Science Information Networks .................................................... 1  
   Jiawei Han

Towards Faster Estimation of Statistics and ODEs Under Interval, P-Box, and Fuzzy Uncertainty: From Interval Computations to Rough Set-Related Computations ........................................ 3  
   Vladik Kreinovich

Rough Set Based Uncertain Knowledge Expressing and Processing ..... 11  
   Guoyin Wang

What is a Fuzzy Concept Lattice? II ................................. 19  
   Radim Belohlavek

Rough Set Based Ensemble Classifier ............................... 27  
   C.A. Murthy, Suman Saha, and Sankar K. Pal

Tutorial Papers

The Use of Rough Set Methods in Knowledge Discovery in Databases: Tutorial Abstract .................................................. 28  
   Marcin Szczuka

Fuzzy-Rough Data Mining ........................................ 31  
   Richard Jensen

Rough Sets and Approximations

Dual Rough Approximations in Information Tables with Missing Values .......................................................... 36  
   Michinori Nakata and Hiroshi Sakai

Rough Sets and General Basic Set Assignments ................. 44  
   Tong-Jun Li and Wei-Zhi Wu

General Tool-Based Approximation Framework Based on Partial Approximation of Sets ...................................... 52  
   Zoltán Csajbók and Tamás Mihálydeák
# Table of Contents

An Improved Variable Precision Model of Dominance-Based Rough Set Approach ................................................................. 60
  *Weibin Deng, Guoyin Wang, and Feng Hu*

Rough Numbers and Rough Regression ................................................................. 68
  *Marcin Michalak*

## Coverings and Granules

Covering Numbers in Covering-Based Rough Sets ........................................... 72
  *Shiping Wang, Fan Min, and William Zhu*

On Coverings of Rough Transformation Semigroups ....................................... 79
  *S.P. Tiwari and Shambhu Sharan*

Covering Rough Set Model Based on Multi-granulations ................................... 87
  *Caihui Liu and Duoqian Miao*

A Descriptive Language Based on Granular Computing – Granular Logic ........... 91
  *Qing Liu and Lan Liu*

## Fuzzy Set Models

Optimization and Adaptation of Dynamic Models of Fuzzy Relational Cognitive Maps ................................................................. 95
  *Grzegorz Słoń and Alexander Yastrebov*

Sensitivity Analysis for Fuzzy Linear Programming Problems ......................... 103
  *Amit Kumar and Neha Bhatia*

Estimation of Parameters of the Empirically Reconstructed Fuzzy Model of Measurements ................................................................. 111
  *Tatiana Kopit and Alexey Chulichkov*

Dominance-Based Rough Set Approach for Possibilistic Information Systems ................................................................. 119
  *Tuan-Fang Fan, Churn-Jung Liau, and Duen-Ren Liu*

Creating Fuzzy Concepts: The One-Sided Threshold, Fuzzy Closure and Factor Analysis Methods ................................................................. 127
  *Valerie Cross and Meenakshi Kandasamy*

Position Paper: Pragmatics in Fuzzy Theory .................................................. 135
  *Karl Erich Wolff*
Fuzzy Set Applications

Regularization of Fuzzy Cognitive Maps for Hybrid Decision Support System .......................................................... 139
Alexey N. Averkin and Sergei A. Kaunov

On Designing of Flexible Neuro-Fuzzy Systems for Nonlinear Modelling .................................................... 147
Krzysztof Cpaś, Olga Rebrova, Robert Nowicki, and Leszek Rutkowski

Time Series Processing and Forecasting Using Soft Computing Tools ... 155
Nadezhda Yarushkina, IrinaPerfilieva, Tatjana Afanasiyeva, Andrew Igonin, Anton Romanov, and Valeria Shishkina

Fuzzy Linear Programming – Foreign Exchange Market ............... 163
Biljana R. Petreska, Tatjana D. Kolemiseska-Gugulovska, and Georgi M. Dimirovski

Fuzzy Optimal Solution of Fuzzy Transportation Problems with Transshipments .................................................. 167
Amit Kumar, Amarpreet Kaur, and Manjot Kaur

Fuzzy Optimal Solution of Fully Fuzzy Project Crashing Problems with New Representation of LR Flat Fuzzy Numbers ...................... 171
Amit Kumar, Parmpreet Kaur, and Jagdeep Kaur

A Prototype System for Rule Generation in Lipski’s Incomplete Information Databases ............................................ 175
Hiroshi Sakai, Michinori Nakata, and Dominik Ślezak

Compound Values

How to Reconstruct the System’s Dynamics by Differentiating Interval-Valued and Set-Valued Functions ......................... 183
Karen Villaverde and Olga Kosheleva

Symbolic Galois Lattices with Pattern Structures ....................... 191
Prakhar Agarwal, Mehdi Kaytoue, Sergei O. Kuznetsov, Amedeo Napoli, and Géraldine Polaillon

Multiargument Relationships in Fuzzy Databases with Attributes Represented by Interval-Valued Possibility Distributions ............ 199
Krzysztof Myszkorowski

Disjunctive Set-Valued Ordered Information Systems Based on Variable Precision Dominance Relation .......................... 207
Guoyin Wang, Qing Shan Yang, and Qing Hua Zhang
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Interval-Valued Fuzzy Soft Set Approach for Normal Parameter</td>
<td>211</td>
</tr>
<tr>
<td>Reduction</td>
<td></td>
</tr>
<tr>
<td><em>Xiuqin Ma and Norrozila Sulaiman</em></td>
<td></td>
</tr>
<tr>
<td><strong>Feature Selection and Reduction</strong></td>
<td></td>
</tr>
<tr>
<td>Incorporating Game Theory in Feature Selection for Text Categorization</td>
<td>215</td>
</tr>
<tr>
<td><em>Nouman Azam and JingTao Yao</em></td>
<td></td>
</tr>
<tr>
<td>Attribute Reduction in Random Information Systems with Fuzzy Decisions</td>
<td>223</td>
</tr>
<tr>
<td><em>Wei-Zhi Wu and You-Hong Xu</em></td>
<td></td>
</tr>
<tr>
<td>Discernibility-Matrix Method Based on the Hybrid of Equivalence and</td>
<td>231</td>
</tr>
<tr>
<td>Dominance Relations</td>
<td></td>
</tr>
<tr>
<td><em>Yan Li, Jin Zhao, Na-Xin Sun, Xi-Zhao Wang, and Jun-Hai Zhai</em></td>
<td></td>
</tr>
<tr>
<td>Studies on an Effective Algorithm to Reduce the Decision Matrix</td>
<td>240</td>
</tr>
<tr>
<td><em>Takurou Nishimura, Yuichi Kato, and Tetsuro Saeki</em></td>
<td></td>
</tr>
<tr>
<td>Accumulated Cost Based Test-Cost-Sensitive Attribute Reduction</td>
<td>244</td>
</tr>
<tr>
<td><em>Huaping He and Fan Min</em></td>
<td></td>
</tr>
<tr>
<td><strong>Clusters and Concepts</strong></td>
<td></td>
</tr>
<tr>
<td>Approximate Bicluster and Tricluster Boxes in the Analysis of Binary</td>
<td>248</td>
</tr>
<tr>
<td>Data</td>
<td></td>
</tr>
<tr>
<td><em>Boris G. Mirkin and Andrey V. Kramarenko</em></td>
<td></td>
</tr>
<tr>
<td>From Triconcepts to Triclusters</td>
<td>257</td>
</tr>
<tr>
<td>*Dmitry I. Ignatov, Sergei O. Kuznetsov, Ruslan A. Magizov, and</td>
<td></td>
</tr>
<tr>
<td>Leonid E. Zhukov</td>
<td></td>
</tr>
<tr>
<td>Learning Inverted Dirichlet Mixtures for Positive Data Clustering</td>
<td>265</td>
</tr>
<tr>
<td><em>Taoufik Bdiri and Nizar Bouguila</em></td>
<td></td>
</tr>
<tr>
<td>Developing Additive Spectral Approach to Fuzzy Clustering</td>
<td>273</td>
</tr>
<tr>
<td><em>Boris G. Mirkin and Susana Nascimento</em></td>
<td></td>
</tr>
<tr>
<td><strong>Rules and Trees</strong></td>
<td></td>
</tr>
<tr>
<td>Data-Driven Adaptive Selection of Rules Quality Measures for</td>
<td>278</td>
</tr>
<tr>
<td>Improving the Rules Induction Algorithm</td>
<td></td>
</tr>
<tr>
<td><em>Marek Sikora and Lukasz Wróbel</em></td>
<td></td>
</tr>
</tbody>
</table>
Table of Contents  

Relationships between Depth and Number of Misclassifications for Decision Trees .............................................................. 286  
Igor Chikalov, Shahid Hussain, and Mikhail Moshkov

Dynamic Successive Feed-Forward Neural Network for Learning Fuzzy Decision Tree ............................................................ 293  
Manu Pratap Singh

An Improvement for Fast-Flux Service Networks Detection Based on Data Mining Techniques .................................................. 302  
Ziniu Chen, Jian Wang, Yujian Zhou, and Chunping Li

Online Learning Algorithm for Ensemble of Decision Rules .......................................................... 310  
Igor Chikalov, Mikhail Moshkov, and Beata Zielosko

Image Processing

Automatic Image Annotation Based on Low-Level Features and Classification of the Statistical Classes ........................................... 314  
Andrey Bronevich and Alexandra Melnichenko

Machine Learning Methods in Character Recognition .......................... 322  
Lev Itskovich and Sergei Kuznetsov

A Liouville-Based Approach for Discrete Data Categorization .............. 330  
Nizar Bouguila

Image Recognition with a Large Database Using Method of Directed Enumeration Alternatives Modification .......................... 338  
Andrey V. Savchenko

Interactions and Visualisation

Comparators for Compound Object Identification ........................................... 342  
Lukasz Sosnowski and Dominik Ślezak

Measuring Implicit Attitudes in Human-Computer Interactions ............ 350  
Andrey Kiselev, Niyaz Abdikeev, and Toyoaki Nishida

Visualization of Semantic Network Fragments Using Multistripe Layout ............................................................. 358  
Alexey Lakhno and Andrey Chepovskiy

Pawlak Collaboration Graph and Its Properties ..................................... 365  
Zbigniew Suraj, Piotr Grochowalski, and Lukasz Lew

Author Index ............................................................................. 369