# Table of Contents

## Plenary Papers

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Networks</td>
<td>1</td>
</tr>
<tr>
<td><em>Zdzisław Pawlak</em></td>
<td></td>
</tr>
<tr>
<td>Toward Rough Set Foundations. Mereological Approach</td>
<td>8</td>
</tr>
<tr>
<td><em>Lech Polkowski</em></td>
<td></td>
</tr>
<tr>
<td>Generalizations of Rough Sets: From Crisp to Fuzzy Cases</td>
<td>26</td>
</tr>
<tr>
<td><em>Masahiro Inuiguchi</em></td>
<td></td>
</tr>
</tbody>
</table>

## Theory

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation about Time Monotonicity of Similarity and Preclusive Rough Approximations in Incomplete Information Systems</td>
<td>38</td>
</tr>
<tr>
<td><em>Gianpiero Cattaneo and Davide Ciucci</em></td>
<td></td>
</tr>
<tr>
<td>The Ordered Set of Rough Sets</td>
<td>49</td>
</tr>
<tr>
<td><em>Jouni Järvinen</em></td>
<td></td>
</tr>
<tr>
<td>A Comparative Study of Formal Concept Analysis and Rough Set Theory in Data Analysis</td>
<td>59</td>
</tr>
<tr>
<td><em>Yiyu Yao</em></td>
<td></td>
</tr>
<tr>
<td>Structure of Rough Approximations Based on Molecular Lattices</td>
<td>69</td>
</tr>
<tr>
<td><em>Jian-Hua Dai</em></td>
<td></td>
</tr>
<tr>
<td>Rough Approximations under Level Fuzzy Sets</td>
<td>78</td>
</tr>
<tr>
<td><em>W.-N. Liu, JingTao Yao, and Yiyu Yao</em></td>
<td></td>
</tr>
<tr>
<td>Fuzzy-Rough Modus Ponens and Modus Tollens as a Basis for Approximate Reasoning</td>
<td>84</td>
</tr>
<tr>
<td><em>Masahiro Inuiguchi, Salvatore Greco, and Roman Słowiński</em></td>
<td></td>
</tr>
</tbody>
</table>

## Logic and Rough Sets

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rough Truth, Consequence, Consistency and Belief Revision</td>
<td>95</td>
</tr>
<tr>
<td><em>Mohua Banerjee</em></td>
<td></td>
</tr>
<tr>
<td>A Note on Ziarko’s Variable Precision Rough Set Model and Nonmonotonic Reasoning</td>
<td>103</td>
</tr>
<tr>
<td><em>Tetsuya Murai, Masayuki Sanada, Y. Kudo, and Mineichi Kudo</em></td>
<td></td>
</tr>
</tbody>
</table>
Fuzzy Reasoning Based on Propositional Modal Logic ................. 109
Zaiyue Zhang, Yuefei Sui, and Cungen Cao

Granular Computing

Approximation Spaces and Information Granulation .................. 116
Andrzej Skowron, Roman Swiniarski, and Piotr Synak
Granular Language and Its Applications in Problem Solving .......... 127
Qing Liu
Belief Reasoning, Revision and Fusion by Matrix Algebra .......... 133
Chun-Jung Liau

Rough and Fuzzy Relations

On the Correspondence between Approximations and Similarity .... 143
Patrick Doherty and Andrzej Szalas
Toward Rough Knowledge Bases with Quantitative Measures .......... 153
Aida Vitória, Carlos Viegas Damásio, and Jan Małuszynski
Considering Semantic Ambiguity and Indistinguishability for Values
of Membership Attribute in Possibility-Based Fuzzy Relational Models ... 159
Michinori Nakata

Foundations of Data Mining

Research on Integrating Ordbms and Rough Set Theory ............ 169
HuiQin Sun, Zhang Xiong, and Ye Wang
Feature Subset Selection
Based on Relative Dependency between Attributes ..................... 176
Jianchao Han, Xiaohua Hu, and Tsao Young Lin
Granular Computing on Extensional Functional Dependencies
for Information System .................................................... 186
Qiusheng An and Junyi Shen
Greedy Algorithm for Decision Tree Construction
in Context of Knowledge Discovery Problems .......................... 192
Mikhail Ju. Moshkov
GAMInG – A Framework for Generalization of Association Mining
via Information Granulation ............................................. 198
Ying Xie and Vijay V. Raghavan
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining Un-interpreted Generalized Association Rules by Linear Inequalities</td>
<td>204</td>
</tr>
<tr>
<td>Tsau Young Lin</td>
<td></td>
</tr>
<tr>
<td>A Graded Applicability of Rules</td>
<td>213</td>
</tr>
<tr>
<td>Anna Gomolińska</td>
<td></td>
</tr>
<tr>
<td>On the Degree of Independence of a Contingency Matrix</td>
<td>219</td>
</tr>
<tr>
<td>Shoji Hirano and Shusaku Tsumoto</td>
<td></td>
</tr>
<tr>
<td>K Nearest Neighbor Classification with Local Induction of the Simple Value Difference Metric</td>
<td>229</td>
</tr>
<tr>
<td>Andrzej Skowron and Arkadiusz Wojna</td>
<td></td>
</tr>
<tr>
<td>A Note on the Regularization Algorithm</td>
<td>235</td>
</tr>
<tr>
<td>Wojciech Jaworski</td>
<td></td>
</tr>
<tr>
<td><strong>Incomplete Information Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Characteristic Relations for Incomplete Data:</td>
<td>244</td>
</tr>
<tr>
<td>A Generalization of the Indiscernibility Relation</td>
<td></td>
</tr>
<tr>
<td>Jerzy W. Grzymala-Busse</td>
<td></td>
</tr>
<tr>
<td>Data Decomposition and Decision Rule Joining for Classification of Data with Missing Values</td>
<td>254</td>
</tr>
<tr>
<td>Rafał Latkowski and Michał Mikołajczyk</td>
<td></td>
</tr>
<tr>
<td><strong>Interestingness</strong></td>
<td></td>
</tr>
<tr>
<td>Bayesian Confirmation Measures within Rough Set Approach</td>
<td>264</td>
</tr>
<tr>
<td>Salvatore Greco, Zdzisław Pawlak, and Roman Słowiński</td>
<td></td>
</tr>
<tr>
<td>Discovering Maximal Potentially Useful Association Rules Based on Probability Logic</td>
<td>274</td>
</tr>
<tr>
<td>Jitender Deogun, Liying Jiang, and Vijay V. Raghavan</td>
<td></td>
</tr>
<tr>
<td>Semantics and Syntactic Patterns in Data</td>
<td>285</td>
</tr>
<tr>
<td>Eric Louie and Tsau Young Lin</td>
<td></td>
</tr>
<tr>
<td><strong>Multiagents and Information Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Dialogue in Rough Context</td>
<td>295</td>
</tr>
<tr>
<td>Mihir K. Chakraborty and Mohua Banerjee</td>
<td></td>
</tr>
<tr>
<td>Constrained Sums of Information Systems</td>
<td>300</td>
</tr>
<tr>
<td>Andrzej Skowron and Jarosław Stepiuk</td>
<td></td>
</tr>
</tbody>
</table>
Defeasible Deontic Control for Discrete Events Based on EVALPSN 310
Kazumi Nakamatsu, Hayato Komaba, Atsuyuki Suzuki,
Chung-Lun Lie, and Sheng-Luen Chung

Fuzzy Logic and Modeling

Rough Set Based Fuzzy Modeling by Occupancy Degree
and Optimal Partition of Projection 316
Chang-Woo Park, Young-Wan Cho, Jun-Hyuk Choi,
and Ha-Gyeong Sung

A Novel High Performance Fuzzy Controller
Applied to Traffic Control of ATM Networks 327
Mahdi Jalili-Kharaajoo

Design of a Speed Drive Based on Fuzzy Logic
for a Dual Three-Phase Induction Motor 334
Mahdi Jalili-Kharaajoo

Rough Classification

Rough Set Theory Analysis on Decision Subdivision 340
Jiucheng Xu, Junyi Shen, and Guoyin Wang

Rough Set Methods in Approximation of Hierarchical Concepts 346
Jan G. Bazan, Sinh Hoa Nguyen, Hung Son Nguyen,
and Andrzej Skowron

Classifiers Based on Two-Layered Learning 356
Jan G. Bazan

Rough Fuzzy Integrals for Information Fusion and Classification 362
Tao Guan and Boqin Feng

Rough Sets and Probabilities

Towards Jointree Propagation with Conditional Probability Distributions 368
Cory J. Butz, Hong Yao, and Howard J. Hamilton

Condition Class Classification Stability in RST
due to Continuous Value Discretisation 378
Malcolm J. Beynon

The Rough Bayesian Model for Distributed Decision Systems 384
Dominik Ślęzak
Variable Precision Rough Set Model

On Learnability of Decision Tables ........................................ 394
   Wojciech Ziarko

Remarks on Approximation Quality
in Variable Precision Fuzzy Rough Sets Model .......................... 402
   Alicja Mieszkowicz-Rolka and Leszek Rolka

The Elucidation of an Iterative Procedure to β-Reduct Selection
in the Variable Precision Rough Sets Model ............................. 412
   Malcolm J. Beynon

Spatial Reasoning

A Logic-Based Framework for Qualitative Spatial Reasoning
in Mobile GIS Environment .............................................. 418
   Mohammad Reza Malek

Spatial Object Modeling in Intuitionistic Fuzzy Topological Spaces ...... 427
   Mohammad Reza Malek

Rough Spatial Interpretation ............................................. 435
   Shuliang Wang, Hanning Yuan, Guoqing Chen, Deren Li,
   and Wenzhong Shi

Reduction

A Scalable Rough Set Knowledge Reduction Algorithm .................. 445
   Zhengren Qin, Guoyin Wang, Yu Wu, and Xiaorong Xue

Tree-Like Parallelization of Reduct and Construct Computation ........ 455
   Robert Susmaga

Heuristically Fast Finding of the Shortest Reducts ..................... 465
   Tsau Young Lin and Ping Yin

Study on Reduct and Core Computation
in Incompatible Information Systems .................................... 471
   Tian-rui Li, Ke-yun Qing, Ning Yang, and Yang Xu

The Part Reductions in Information Systems ............................ 477
   Chen Degang

Rule Induction

Rules from Belief Networks: A Rough Set Approach ..................... 483
   Teresa Mroczek, Jerzy W. Grzymała-Busse, and Zdzisław S. Hippe
The Bagging and $n^2$-Classifiers Based on Rules Induced by MODLEM .... 488  
Jerzy Stefanowski

A Parallel Approximate Rule Extracting Algorithm Based on the Improved Discernibility Matrix ..................... 498  
Liu Yong, Xu Congfu, and Pan Yunhe

Decision Rules in Multivalued Decision Systems .................. 504  
Wojciech Rząsa, Artur Paluch, and Zbigniew Suraj

Multicriteria Choice and Ranking Using Decision Rules Induced from Rough Approximation of Graded Preference Relations ...... 510  
Philippe Fortemps, Salvatore Greco, and Roman Słowiński

Measuring the Expected Impact of Decision Rule Application ........ 523  
Salvatore Greco, Benedetto Matarazzo, Nello Pappalardo, and Roman Słowiński

Detection of Differences between Syntactic and Semantic Similarities ..... 529  
Shoji Hirano and Shusaku Tsumoto

**Rough Sets and Neural Network**

Processing of Musical Data Employing Rough Sets and Artificial Neural Networks .................................................. 539  
Bozena Kostek, Piotr Szczuko, and Pawel Zwan

Integration of Rough Set and Neural Network for Application of Generator Fault Diagnosis ................................. 549  
Wei-ji Su, Yu Su, Hai Zhao, Xiao-dan Zhang

Harnessing Classifier Networks – Towards Hierarchical Concept Construction ........................................................... 554  
Dominik Ślęzak, Marcin S. Szczuka, and Jakub Wróblewski

Associative Historical Knowledge Extraction from the Structured Memory ............................................................. 561  
JeongYon Shim

**Clustering**

Utilizing Rough Sets and Multi-objective Genetic Algorithms for Automated Clustering ........................................ 567  
Tansel Özyer, Reda Alhajj, and Ken Barker

Towards Missing Data Imputation: A Study of Fuzzy K-means Clustering Method ............................................. 573  
Dan Li, Jitender Deogun, William Spaulding, and Bill Shuart
K-means Indiscernibility Relation over Pixels .......................... 580
James F. Peters and Maciej Borkowski

A New Cluster Validity Function
Based on the Modified Partition Fuzzy Degree .......................... 586
Jie Li, Xinbo Gao, and Li-cheng Jiao

Data Mining

On the Evolution of Rough Set Exploration System ................. 592
Jan G. Bazan, Marcin S. Szczuka, Arkadiusz Wojna, and Marcin Wojnarski

Discovering Maximal Frequent Patterns in Sequence Groups .... 602
J.W. Guan, David A. Bell, and Dayou Liu

Fuzzy Taxonomic, Quantitative Database
and Mining Generalized Association Rules ......................... 610
Hong-bin Shen, Shi-tong Wang, and Jie Yang

Pattern Mining for Time Series Based on Cloud Theory Pan-concept-tree . 618
Yingjun Weng and Zhongying Zhu

Using Rough Set Theory for Detecting the Interaction Terms
in a Generalized Logit Model ..................................... 624
Chorng-Shyong Ong, Jih-Jeng Huang, and Gwo-Hshiung Tzeng

Optimization of the ABCD Formula for Melanoma Diagnosis Using C4.5,
a Data Mining System ............................................. 630
Ron Andrews, Stanislaw Bajcar, Jerzy W. Grzymala-Busse,
Zdzislaw S. Hippe, and Chris Whiteley

A Contribution to Decision Tree Construction
Based on Rough Set Theory .................................... 637
Xumin Liu, Houkuan Huang, and Weixiang Xu

Image and Signal Recognition

Domain Knowledge Approximation in Handwritten Digit Recognition .... 643
Tuan Trung Nguyen

An Automatic Analysis System for Firearm Identification
Based on Ballistics Projectile ................................... 653
Jun Kong, Dongguang Li, and Chunnong Zhao

Granulation Based Image Texture Recognition ........................ 659
Zheng Zheng, Hong Hu, and Zhongzhi Shi
Radar Emitter Signal Recognition Based on Resemblance Coefficient Features
Gexiang Zhang, Haina Rong, Weidong Jin, and Laizhao Hu

Vehicle Tracking Using Image Processing Techniques
Seung Hak Rhee, Seungjo Han, Pan koo Kim, Muhammad Bilal Ahmad, and Jong An Park

Classification of Swallowing Sound Signals: A Rough Set Approach
Lisa Lazareck and Sheela Ramanna

Emotional Temporal Difference Learning Based Multi-layer Perceptron
Neural Network Application to a Prediction of Solar Activity
Farzan Rashidi and Mehran Rashidi

Information Retrieval
Musical Metadata Retrieval with Flow Graphs
Andrzej Czyzewski and Bozena Kostek

A Fuzzy-Rough Method for Concept-Based Document Expansion
Yan Li, Simon Chi-Keung Shiu, Sankar Kumar Pal, and James Nga-Kwok Liu

Use of Preference Relation for Text Categorization
Hayri Sever, Zafer Bolat, and Vijay V. Raghavan

Decision Support
An Expert System for the Utilisation of the Variable Precision Rough Sets Model
Malcolm J. Beynon and Benjamin Griffiths

Application of Decision Units in Knowledge Engineering
Roman Siminski and Alicja Wakulicz-Deja

Fuzzy Decision Support System with Rough Set Based Rules Generation Method
Grzegorz Drwal and Marek Sikora

Approximate Petri Nets for Rule-Based Decision Making
Barbara Fryc, Krzysztof Pancerz, and Zbigniew Suraj

Adaptive and Optimization Methods
Adaptive Linear Market Value Functions for Targeted Marketing
Jiajin Huang, Ning Zhong, Chunnian Liu, and Yiyu Yao
Using Markov Models to Define Proactive Action Plans for Users at Multi-viewpoint Websites .................................................. 752
Ernestina Menasalvas, Socorro Millán, and P. Gonzalez

A Guaranteed Global Convergence Particle Swarm Optimizer .......... 762
Zhihua Cui and Jianchao Zeng

Adaptive Dynamic Clone Selection Algorithms.......................... 768
Haifeng Du, Li-cheng Jiao, Maoguo Gong, and Ruochen Liu

Multiobjective Optimization Based on Coevolutionary Algorithm .... 774
Jing Liu, Weicai Zhong, Li-cheng Jiao, and Fang Liu

Bioinformatics

Extracting Protein-Protein Interaction Sentences by Applying Rough Set Data Analysis .................................................. 780
Filip Ginter, Tapio Pahikkala, Sampo Pyysalo, Jorma Boberg,
Jouni Järvinen, and Tapio Salakoski

Feature Synthesis and Extraction for the Construction of Generalized Properties of Amino Acids ........................................ 786
Witold R. Rudnicki and Jan Komorowski

Improvement of the Needleman-Wunsch Algorithm .................... 792
Zhihua Du and Feng Lin

The Alignment of the Medical Subject Headings to the Gene Ontology and Its Application in Gene Annotation ......................... 798
Henrik Tveit, Torulf Mollestad, and Astrid Lægreid

Medical Applications

Rough Set Methodology in Clinical Practice:
Controlled Hospital Trial of the MET System ......................... 805
Ken Farion, Wojtek Michalowski, Roman Słowiński, Szymon Wilk,
and Steven Rubin

An Automated Multi-spectral MRI Segmentation Algorithm
Using Approximate Reducts .................................................. 815
Sebastian Widz, Kenneth Revett, and Dominik Ślężak

Rough Set-Based Classification of EEG-Signals to Detect Intraoperative Awareness: Comparison of Fuzzy and Crisp Discretization of Real Value Attributes ......................... 825
Michael Ningler, Gudrun Stockmanns, Gerhard Schneider,
Oliver Dressler, and Eberhard F. Kochs
Fuzzy Logic-Based Modeling of the Biological Regulator of Blood Glucose .......................... 835
José-Luis Sánchez Romero, Francisco-Javier Ferrández Pastor,
Antonio Soriano Payá, and Juan-Manuel García Chamizo

Bibliography Project of International Rough Set Society

The Rough Set Database System: An Overview ........................ 841
Zbigniew Suraj and Piotr Grochowalski

Author Index .................................................... 851