

THE 5TH INTERNATIONAL FUZZY SYSTEMS SYMPOSIUM 2017

PROGRAMME and ABSTRACTS

October 14 - 15, 2017

Ankara, Turkey

<http://fuzzyss2017.etu.edu.tr/>

Organized by

Fuzzy Systems Association

TOBB University of Economics & Technology

PREFACE

The Fifth International Fuzzy System Symposium (FUZZYSS'17) dedicated to Professor I. Burhan TURKSEN is organized by Fuzzy System Association in TOBB University of Economics and Technology. During FUZZYSS'17 a total of 115 oral presentations and four invited speeches are given. Prof. Dr. Ibrahim Ozkan, Prof. Dr. Adil Baykasoglu, Prof. Dr. Omer Akin and Assoc. Prof. Dr. Cagdas Hakan Aladag mention on the uncertainty, uncertainty management, and historical development of fuzzy systems. The oral presentations from different application areas are given during FUZZYSS'17. This programme and abstract book includes the abstracts of all accepted and presented studies. After FUZZYSS'17, some selected full-text papers will be published in special issues of the International Journals.

We believe that FUZZYSS series will provide some important contributions to the scientific developments in fuzzy systems in Turkey and its neighboring countries.

C.H. Aladag Ph.D., D. Alptekin, B. Alptekin

Editors

THE 5th INTERNATIONAL FUZZY SYSTEMS SYMPOSIUM

October 14-15, 2017

Dedicated to
Prof. İ. Burhan TURKSEN



The 5th International Fuzzy Systems Symposium (FUZZYSS'17)
will be held at the TOBB University of Economic and
Technology, Ankara / Turkey on October 14-15, 2017.

Abstract Submission Deadline

August 30, 2017

Full-Text Paper Submission Deadline (Optional)

October 30, 2017

Registration Deadline

September 11, 2017



For more information,
please visit the conference website:
fuzzyss2017.etu.edu.tr



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Programme and abstract book edited by: Deniz Alptekin & Bulent Alptekin

PROGRAMME OVERVIEW

Saturday, October 14, 2017

08.30 – 10.00	Registration
09.00 – 10.45	Opening Ceremony
10.45 – 11.00	Coffee Break
11.00 – 12.00	Invited Speaker
12.00 – 13.30	Lunch Break
13.30 – 14.15	Invited Speaker
14.15 – 14.30	Coffee Break
14.30 – 15.30	Contributed Paper Session I
15.30 – 15.45	Coffee Break
15.45 – 16.45	Contributed Paper Session II
16.45 – 17.00	Coffee Break
17.00 – 18.15	Contributed Paper Session III
18.30 –	Conference Dinner

Sunday, October 15, 2017

09.00 – 09.45	Invited Speaker
09.45 – 10.00	Coffee Break
10.00 – 11.00	Contributed Paper Session IV
11.00 – 11.15	Coffee Break
11.15 – 12.15	Contributed Paper Session V
12.15 – 13.30	Lunch Break
13.30 – 14.15	Invited Speaker
14.15 – 14.30	Coffee Break
14.30 – 15.30	Contributed Paper Session VI
15.30 – 15.45	Coffee Break
15.45 – 16.45	Contributed Paper Session VII
16.45 – 17.00	Coffee Break
17.00 – 18.00	Contributed Paper Session VIII
18.00 – 18.15	Coffee Break
18.15 – 19.30	Contributed Paper Session IX

DETAILED PROGRAMME

Saturday, October 14, 2017

Registration	08.30 – 10.00
Opening Ceremony	09.00 – 10.45
Coffee Break: 10.45 – 11.00	
Invited Lecture Session	
<i>Ibrahim Ozkan</i>	11.00 – 12.00
<i>I. B. Turksen's 40 Years of Contributions to Fuzzy Logic and Fuzzy System Modelling</i>	
Lunch Break: 12.00 – 13.30	
Invited Lecture Session	
<i>Adil Baykasoglu</i>	13.30 – 14.15
<i>Interval Type-2 Fuzzy Cognitive Maps</i>	
Coffee Break: 14.15 – 14.30	
Contributed Paper Session I	
Chair: Candan Gokceoglu Room: İsmail	14.30 – 15.30 October 14, 2017
Volkan Sonmez, Murat Caner Testik, Özlem Müge Testik	
<i>A Tool for Calculating Fuzzy and Interval Production Loss Measurements</i>	
14.30 – 14.45	
Burcu Felekoglu, Adil Baykasoglu, Ilker Golcuk	
<i>A Systematic Approach for Building and Analyzing Problem Solving Networks in Open Innovation</i>	
14.45 – 15.00	
Deniz Sönmez, Gürsel Yeşilot, Serkan Onar, Bayram Ali Ersoy	
<i>A Note on 2-Absorbing Primary Fuzzy Ideals</i>	
15.00 – 15.15	
Ahmet Egesoy	
<i>Choosing Fuzzy Operators for Real-life Engineering Applications</i>	
15.15 – 15.30	

Contributed Paper Session I		14.30 – 15.30
Chair: Mehmet Karaköse Room: Burhan		October 14, 2017
<hr/>		
Yunus Santur, Mehmet Karaköse, Erhan Akin		
<i>Fuzzy Logic Based Decision Making and Risk Analysis Approach for Railway Inspection</i>		
14.30 – 14.45		
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Canan Tastimur, Mehmet Karaköse, Erhan Akin		
<i>Hierarchical Fuzzy System Based Classification Approach for Railway Components Using Vision Inspection</i>		
14.45 – 15.00		
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Mustafa Hamurcu, Tamer Eren		
<i>Selection of Urban Rail Transport Type by Using Fuzzy AHP</i>		
15.00 – 15.15		
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Gulsah Karaduman, Mehmet Karaköse, Erhan Akin		
<i>A Method of Using Fuzzy Decision Trees for Fault Diagnosis of Pantograph-Catenary Systems</i>		
15.15 – 15.30		
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Contributed Paper Session I		14.30 – 15.30
Chair: Şebnem Yılmaz Balaman Room: Türkşen		October 14, 2017
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Esin Mukul, Merve Güler, Gülçin Büyükoçkan		
<i>Hesitant Fuzzy Linguistic COPRAS Method for Marketing Strategy Selection</i>		
14.30 – 14.45		
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M.Sami Sivri, Sevinç Özgün, Parmis Shah Maleki		
<i>Interval Valued Hesitant Fuzzy Analytic Hierarchy Process and Its Application to Group Decision Making</i>		
14.45 – 15.00		
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Mucahit Karaduman, Muharrem Tuncay Gencoglu, Haluk Eren		
<i>A Fuzzy Decision System for Car Fault Diagnosis Using Vibration Data</i>		
15.00 – 15.15		
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Sedef Çalı, Şebnem Yılmaz Balaman		
<i>A Methodology for Analytic Customer Relationship Management: Integration of Intuitionistic Fuzzy ELECTRE and VIKOR</i>		
15.15 – 15.30		
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Coffee Break: 15.30 – 15.45		
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Contributed Paper Session II	15.45 – 16.45
Chair: Adnan Aktepe Room: İsmail	October 14, 2017
Duygun Fatih Demirel, Melek Başak <i>A Higher Order Fuzzy Lee-Carter Method for Modeling Human Migration</i> 15.45 – 16.00	
Adnan Aktepe, Melda Kokoç, Süleyman Ersöz <i>Determining Market Strategy by Using a Fuzzy Rule Based Algorithm</i> 16.00 – 16.15	
Nursin Bas Catak <i>Numerical Solutions of Aggregation Processes Based on Fuzzy Markov Chains</i> 16.15 – 16.30	
Gültekin Atalık, Sevil Şentürk <i>A Comparison Study of Fuzzy Logistic Regression Models with Different Criteria</i> 16.30 – 16.45	
Contributed Paper Session II	15.45 – 16.45
Chair: Şebnem Yılmaz Balaman Room: Burhan	October 14, 2017
Melika Mohsenizadeh, Elcin Kentel, Mustafa Kemal Tural <i>Municipal Solid Waste Management with Cost Minimization and Emission Control Objectives</i> 15.45 – 16.00	
Busra Akarsu, Koray Sener Parlak, Alişan Sarimaden, Mehmet Karakose <i>A Fuzzy Integration Approach for Feature Extraction Techniques in Image Processing Based Quality Control Applications</i> 16.00 – 16.15	
Şebnem Yılmaz Balaman, Daniel G.Wright, James Scott, Aristides Matopoulos <i>A Fuzzy Optimization Framework for Design of Bio-Waste Based Energy Supply Chains</i> 16.15 – 16.30	
Şebnem Yılmaz Balaman, Daniel G.Wright, James Scott, Aristides Matopoulos <i>A Methodology Based on Fuzzy ε-constraint Method for Integrated Optimization of Sustainable Supply Chains and Transportation Networks for Multi Technology Bio-based Production</i> 16.30 – 16.45	

Contributed Paper Session II	15.45 – 16.45
Chair: <i>Bülent Çekiç</i> Room: <i>Türkşen</i>	October 14, 2017
Mustafa Hamurcu, Tamer Eren <i>A Hybrid Approach Based on Fuzzy AHP and TOPSIS for Selection of Academic Conference</i> 15.45 – 16.00	
Fatma Betül Yeni, Gökhan Özçelik <i>An Extension of CODAS Method with Interval-Valued Intuitionistic Fuzzy Numbers</i> 16.00 – 16.15	
Erkan Celik, Emre Akyuz <i>A Fuzzy SLIM Based Quantitative Risk Analysis in Maritime Transportation Engineering</i> 16.15 – 16.30	
A. Bahadır Şimşek, Bülent Çekiç, K. Barış Atıcı <i>Use of Fuzzy MCDA for Assessment of Emergency Rallying Points</i> 16.30 – 16.45	
Coffee Break: 16.45 – 17.00	
Contributed Paper Session III	17.00 – 18.15
Chair: <i>Sinem Peker</i> Room: <i>İsmail</i>	October 14, 2017
Munevvere Yıldız, Memmedaga Memmedli <i>Fuzzy Local Polynomial Regression Problem and Selection of Parameter</i> 17.00 – 17.15	
Tahir Ceylan, Nihat Altınışık <i>Two-Point Fuzzy Boundary Value Problems with Eigenvalue Parameter Contained in the Boundary Conditions</i> 17.15 – 17.30	
Sinem Peker, Efendi Nasibov <i>A Weighted Approach for Ranking of Fuzzy Numbers</i> 17.30 – 17.45	
Enes Yavuz <i>Korovkin Type Approximation of Continuous Fuzzy-Number-Valued Functions via Power Series Methods of Summability</i> 17.45 – 18.00	
Nurgül Okur, Sercan Turhan <i>Hermite-Hadamard Type Inequality for Strongly Preinvex Functions via Sugeno Integrals</i> 18.00 – 18.15	

Contributed Paper Session III**17.00 – 18.15****Chair: İlhan Aydın Room: Burhan**October 14, 2017

Gül Didem Batur, Emre Çalışkan

*Evaluation of Development Regions in Turkey in Terms of IPA Supports Using Fuzzy PROMETHEE and Fuzzy MULTIMOORA*17.00 – 17.15

İlhan Aydın

*Fuzzy Integral and Cuckoo Search Based Combined Classifier for Human Action Recognition*17.15 – 17.30

Burcu Yılmaz Kaya, Metin Dağdeviren

*An Economy Class Service Systems Analysis Based on Fuzzy Methodologies*17.30 – 17.45

Ozer Ozdemir, Asli Kaya

*Fuzzy Clustering Analysis in Gene Expression Data*17.45 – 18.00

Seda Guzel Aydin, Hasan Şakir Bilge

*LabVIEW Based Fuzzy Identifier for Power Quality Disturbances*18.00 – 18.15

Contributed Paper Session III**17.00 – 18.15****Chair: Mehmet Hakan Demir Room: Türkşen**October 14, 2017

Nurdan Yıldız, Fatih Tüysüz

*Simulation Based Multi-Criteria Analysis of the Factors Used for the Evaluation of Retail Location Selection*17.00 – 17.15

Mustafa Hamurcu, Tamer Eren

*Academic Journal Selection for Academicians by Using Fuzzy Multicriteria Decision Making Methods*17.15 – 17.30

Ali Firat Inal, Ahmet Kürşad Türker, Adnan Aktepe, Süleyman Ersöz

*Robot Selection in a Computer Integrated Manufacturing Cell with Fuzzy Multi-Criteria Decision Making*17.30 – 17.45

Ebru Karakose

*A Cooperative Mission Planning of UAV Swarms Based on Fuzzy Decision Making*17.45 – 18.00

Mehmet Hakan Demir, Faruk Yiğit

*Fuzzy Logic Based Control of a Fluid Conveying Cantilever Pipe*18.00 – 18.15

Symposium Dinner: 18.30

Sunday, October 15, 2017

Invited Lecture Session

Omer Akin

09.00 – 09.45

Solving Second Order Intuitionistic Fuzzy Initial Value Problems with Heaviside Function

Coffee Break: 09.45 – 10.00

Contributed Paper Session IV

10.00 – 11.00

Chair: Zeki Ayag Room: İsmail

October 15, 2017

Mustafa Hamurcu, Tamer Eren

Evaluation of Monorail Route Alternatives by Using a Fuzzy Analytic Hierarchy Process

10.00 – 10.15

Erkan Celik, Muhammet Gul, Alev Taskin Gumus, Ali Fuat Guneri

A Review and Classification of Approaches for Dealing with TODIM and Its Applications

10.15 – 10.30

Abdussamet Subaşı, Abit Balin

An Application of Multi-Criteria Decision-Making Approach on Selection of a Honeycomb Heat Sink

10.30 – 10.45

Zeki Ayağ

A Comparison Study of F-AHP Based MCDM Methods on Green Concept Selection Problem

10.45 – 11.00

Contributed Paper Session IV

10.00 – 11.00

Chair: Omer Akin Room: Burhan

October 15, 2017

Fulya Şahin

Intuitionistic Fuzzy Topological Transformation Groups

10.00 – 10.15

Ömer Akın, Selami Bayeğ

Initial Value Problems in Intuitionistic Fuzzy Environment

10.15 – 10.30

Sanem Yavuz, Serkan Onar, Bayram Ali Ersoy, Deniz Sönmez

Intuitionistic Fuzzy 2-Absorbing Primary Ideals of Commutative Rings

10.30 – 10.45

Nurgül Okur, Sercan Turhan

Hermite-Hadamard Type Inequality for Strongly Log-convex Functions via Sugeno Integrals

10.45 – 11.00

Contributed Paper Session IV		10.00 – 11.00
Chair: Adil Baykasoglu Room: Türkşen		October 15, 2017
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Adil Baykasoğlu, İlker Gölcük, Fehmi Burçin Özsoydan		
<i>Improving Fuzzy C-Means Clustering via Weighted Superposition Attraction Algorithm</i>		
10.00 – 10.15		
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Reyhan Shikhlinakaya, Farhad Mirzayev, Arzu Safarova, Narmin Khuliyeva		
<i>Applying the Theory of Fuzzy Time Series in Forecasting of the Rate of USD / AZN</i>		
10.15 – 10.30		
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Baki Ünal		
<i>Comparison of Different Price Formation Models in Double Auctions</i>		
10.30 – 10.45		
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Fatih Cavdur, Merve Kose-Kucuk		
<i>Using Fuzzy Logic for Automobile Pricing</i>		
10.45 – 11.00		
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Coffee Break: 11.00 – 11.15		
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Contributed Paper Session V		11.15 – 12.15
Chair: Mahmut Turhan Room: İsmail		October 15, 2017
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Turan Goktug Altundogan, Mehmet Karakose		
<i>Fuzzy Decision Tree Based Anomaly Classification Method for X-Ray Images</i>		
11.15 – 11.30		
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Mehmet Karakose, Nursena Baygin, Mehmet Baygin		
<i>Fuzzy Based Threshold Time Estimation for Shadow Transition in Reconfiguration Process of PV Arrays</i>		
11.30 – 11.45		
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Mahmut Turhan		
<i>A Fuzzy Weighted Shape Based Vehicle Detection Approach for Traffic Control</i>		
11.45 – 12.00		
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Mahmut Turhan		
<i>A Fuzzy Decision Tree-Based Method for Classification of Satellite Images</i>		
12.00 – 12.15		
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Contributed Paper Session V		11.15 – 12.15
Chair: <i>Sofiya Ostrovska</i> Room: <i>Burhan</i>		October 15, 2017
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Suzan Kantarcı-Savaş, Efendi Nasibov		
<i>A Case Study on Fuzzy Inference with Zadeh T-Operators by FID3-LR Classification Approach</i>		
11.15 – 11.30		
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Merve Uzuner Sahin, Kumru Didem Atalay, Berna Dengiz		
<i>Fuzzy System Availability of a Battery Production System</i>		
11.30 – 11.45		
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Serkan Onar, Bayram Ali Ersoy		
<i>Vague Soft Gamma Semigroup</i>		
11.45 – 12.00		
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Seda Guzel Aydin, Hasan Şakir Bilge		
<i>A Review of EEG Signal Processing Using Fuzzy Systems</i>		
12.00 – 12.15		
Contributed Paper Session V		11.15 – 12.15
Chair: <i>Alptekin Durmuşoğlu</i> Room: <i>Türkşen</i>		October 15, 2017
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Tuba Adar, Elif Kilic Delice		
<i>Evaluating Mental Work Load Using Multi-criteria Hesitant Fuzzy Linguistic Term Set (HFLTSS)</i>		
11.15 – 11.30		
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Zeynep Didem Unutmaz Durmuşoğlu		
<i>A Novel Learning Approach for Fuzzy Cognitive Maps: Relative Differential Hebbian Learning</i>		
11.30 – 11.45		
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Gülçin Canbulut, Hülya Torun		
<i>Analysis of Fuzzy Supply Chain Performance on Buyback Contract Forms</i>		
11.45 – 12.00		
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Alptekin Durmuşoğlu		
<i>A New Approach for Classification Problems: Use of Fuzzy Cognitive Maps with Binary Squeezing Functions</i>		
12.00 – 12.15		
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Lunch Break: 12.15 – 13.30		
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Invited Lecture Session		
Cagdas Hakan Aladag		13.30 – 14.15
<i>A Membership Value Based Performance Measure</i>		
Coffee Break: 14.15 – 14.30		
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Contributed Paper Session VI	14.30 – 15.30
Chair: Erkan Celik Room: İsmail	October 15, 2017
<p>Ezgi Türkarıslan, Mehmet Ünver <i>An Identification of a Fuzzy Measure which is Subadditive over Singletons</i> 14.30 – 14.45</p>	
<p>Ahmet Aktař, Mehmet Kabak <i>A Hesitant Fuzzy Approach for Ranking of European Countries in Terms of Healthcare Services</i> 14.45 – 15.00</p>	
<p>Gölin Feryal Can, Tuba Adar, Elif Kılıç Delice <i>A Fuzzy Approach for Product Selection Considering Universal Design Principles: A Case Study for Military Gas Mask Selection</i> 15.00 – 15.15</p>	
<p>Merve Güler, Esin Mukul, Gülçin Büyüközkın <i>Hesitant Fuzzy Linguistic VIKOR Method for e-Health Technology Selection</i> 15.15 – 15.30</p>	
Contributed Paper Session VI	14.30 – 15.30
Chair: Salih Aytar Room: Burhan	October 15, 2017
<p>Ebru Aydođdu, Abdölkadir Aygünođlu, Halis Aygün <i>Fuzzifying Topology Induced by Fuzzy Metric</i> 14.30 – 14.45</p>	
<p>İsmail Özcan, Salih Aytar <i>Fuzzy Revenue for Linear and Quadratic Demand Functions Using Trapezoidal Fuzzy Numbers</i> 14.45 – 15.00</p>	
<p>Fatma Karaca, Nihal Tař, řakir Sakarya <i>Life Insurances Decision Making Problem</i> 15.00 – 15.15</p>	
<p>Sofiya Ostrovska <i>On the Note of History: Antecedents of Fuzzy Integrals in Ukrainian Mathematics</i> 15.15 – 15.30</p>	

Contributed Paper Session VI	14.30 – 15.30
Chair: Baris Simsek Room: Türkşen	October 15, 2017
Hasan Yetis, Mehmet Karakose <i>Optimization of Nonstationary Fuzzy Logic Systems with Genetic Algorithm for Cyber-Physical Systems</i> 14.30 – 14.45	
Barış Şimşek, Fatih Kara, Haluk Korucu, Vedat Arda Küçük, Mehmet M. Kocakerim <i>Taguchi Orthogonal Arrays Based Fuzzy Modeling and Optimization of Reduced Graphene Oxide Properties</i> 14.45 – 15.00	
Gökçe Kılıçkaya <i>An Application of Fuzzy Linear Programming Model with Zimmerman Method</i> 15.00 – 15.15	
Mehmet Aksaraylı, Osman Pala <i>A New Fuzzy Dynamic Adaptive Particle Swarm Optimization Method for Cardinality Constrained Portfolio Optimization</i> 15.15 – 15.30	
Coffee Break: 15.30 – 15.45	
Contributed Paper Session VII	15.45 – 16.45
Chair: Tahir Hanalioglu Room: İsmail	October 15, 2017
İlker Gölcük, Adil Baykasoğlu <i>Integrating Interval Type-2 Fuzzy DEMATEL and Analytic Network Process for 3PL Transportation Provider Evaluation</i> 15.45 – 16.00	
İlker Murat Ar, Haluk Gökşen <i>Technical Assessment of FTTB Supplier in Telecommunication Industry Using Fuzzy AHP-VIKOR Approach with Interval Type-2 Fuzzy Sets</i> 16.00 – 16.15	
Tahir Khaniyev, M.Bahar Başkır, Farhad Mirzayev, Fikri Gökpınar <i>Statistical Distribution Functions of Type-2 Fuzzy Numbers</i> 16.15 – 16.30	
Hatice Ercan Teksen, Ahmet Sermet Anagün <i>Type 2 Fuzzy Control Charts Using Ranking Methods</i> 16.30 – 16.45	

Contributed Paper Session VII		15.45 – 16.45
Chair: Ahmet Cagdas Room: Burhan		October 15, 2017
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Erdal Kılıç, Sami Şit, Ahmet Gani, Mustafa Şekkeli, Hasan Rıza Özçalık		
<i>Neuro-Fuzzy Based Model Reference Adaptive Control for Induction Motor Drive</i>		
15.45 – 16.00		
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Burak Gülmez, Sinem Kulluk, Hülya Torun		
<i>Training Fuzzy Neural Networks with Social Spider Algorithm</i>		
16.00 – 16.15		
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Asli Akilli, Ozkan Gorgulu		
<i>Prediction of Milk Yield Using Fuzzy Nonlinear Regression with Neural Networks</i>		
16.15 – 16.30		
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Fatih Bozkurt, Ahmet Çağdaş Seçkin, Aysun Coşkun		
<i>Design of Cursor Control Using EEG and IMU Sensor Fusion with ANFIS</i>		
16.30 – 16.45		
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Contributed Paper Session VII		15.45 – 16.45
Chair: Hilal Guney Room: Türkşen		October 15, 2017
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Yılmaz Koçak, Gülesen Üstündağ Şiray		
<i>A Comparison of Conventional Statistical Regression Analysis and Fuzzy Regression</i>		
15.45 – 16.00		
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Yılmaz Koçak, İlhami İlhan		
<i>Investigation of Breaking Force of Chenille Yarn Using Statistical Regression and Fuzzy Regression Analyses</i>		
16.00 – 16.15		
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Hatice Ercan Teksen, Nurcan Deniz		
<i>A Fuzzy Inference Method Based on Logistic Regression for Diabetes Diagnosis</i>		
16.15 – 16.30		
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Asiye Ozge Dengiz, Kumru Didem Atalay, Fulya Altiparmak		
<i>Fuzzy Linear Regression Model for Estimation of Carbon Emission for Light Duty Vehicles</i>		
16.30 – 16.45		
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Coffee Break: 16.45 – 17.00		
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<i>A Decision Support System Based on a Fuzzy-Stochastic Mathematical Program for Intermodal Fleet Planning Problems</i>		
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Adil Baykasoğlu, Kemal Subulan, Gizem Şiker, Selin Atik		
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<i>Fuzzy Logic Control for Pitch and Yaw Angles of a Dual Rotor Helicopter</i>		
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Muhammet Aydın, Oğuz Yakut		
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M.Bahar Başkır		
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I. B. Turksen's 40 Years of Contributions to Fuzzy Logic and Fuzzy System Modelling

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Abstract

Dr. Turksen did not think that his academic career would start with this journey when he was on his way to study Industrial Engineering at the University of Pittsburgh in 1956. The university life that started in 1956 continued for 61 years as both a student and a lecturer and lasted until he retired from the Department of Industrial Engineering at TOBB ETU in 2017. His retirement from the TOBB ETU is his second retirement from the University of Toronto. He earned his bachelor, master and doctoral degrees from the University of Pittsburgh in 1960, 1962 and 1969 respectively. He started teaching at the University of Toronto in 1970 as a lecturer, and his life as an active academician continued until the second half of 2017. He had been teaching and conducting researches including at several universities Toronto, Pittsburgh, METU and TOBB ETU. In addition, he has successfully graduated more than 30 doctoral students and more than 20 graduate students. He formed Knowledge / Intelligence System Lab (KIS) laboratory at the Toronto University and founded IIC Fuzzy Company, where he has signed and finished numerous industry projects. Dr. Turksen's world - wide known career can be seen with all the details from his resume. Here, I will give a brief assessment of Dr. Turksen's academic knowledge production and the transfer of this knowledge to the industries.

Dr. Turksen has several books published by the world's leading publishing houses, such as Elsevier and Springer. There is a recent book devoted to him covering 50 Year Fuzzy Logic. He also has published more than 40 refereed book chapters. In his own words about the publications he has made in his academic life: "I published more than 170 articles in the journals indexed by (S)SCI and I attended many conferences that I could not count." When I do a SCOPUS search for Dr. Turksen, the number of publications I get is 266. As you can see, since Dr. Turksen is a scientist with so many publications that can not be referred here, I will make this presentation without giving you a proper reference list. The publications that started in 1963 are still going on today and it will continue in the coming years.

The 5th International Fuzzy Systems Symposium (FUZZYSS'17)

His Fuzzy Logic researches began with Lotfi Aliasker Zadeh whom he met first during a conference he attended in the mid-1970s. "This is a turning point in terms of my research and understanding of reasoning" he said in his own words. Then his focus turned to the Fuzzy Logic and Fuzzy System Modelling. The main research areas of his study includes (but not limited to); "Fuzzy Logic", "Measuring Fuzziness", "Stochastic Fuzziness", "Decision Systems", "Human-like Reasoning", "Type 1, Interval Valued Type 2 and Type-n Fuzzy Systems", "Fuzzy Hybrid Models". And of course, the application of these models to healthcare, engineering, economics, business and finance. Comparing his research with the history of artificial intelligence reveals parallel development with this field. With the first artificial intelligence workshop (Dartmouth Conference) held in 1956, human-like reasoning has also fallen into the minds of many scientists. Artificial intelligence studies have become widespread in the 1970s and especially since the early 1980s with the successful development of expert systems and rule-based models. In the same period, Dr. Turksen has started to work on Fuzzy Logic, Fuzzy System Models and Human-like Reasoning.

From 1984 onwards, his research has focused on Fuzzy Logic related studies. Until 1990, he specifically worked on "measurement of membership function", "interval valued fuzzy sets", "fuzzy system models" and their applications on production planning.

During the 1990s, he concentrated his research on "fuzzy logic", "reasoning", "interval-valued fuzzy logic", "rule-based systems", "fuzzy clustering", "neuro-fuzzy models". Application areas of these studies include healthcare, consumer preferences and problems in business processes such as inventory management and scheduling.

Dr. Turksen's most productive years may be the 2000s when industrial research projects became the center of his works. The number of researchers working at the KIS laboratory exceeded 10. At the same time, the number of industrial projects KIS Lab researchers worked on was more than 6. These projects include intelligent bandwidth decisions, intelligent control of internet quality services, estimation of credit cardholder risk, estimation of bank customer cash assets, analysis of cancerous treatment from CT and PET scan images and desulphurization in steel production. Fuzzy C-mean clustering with Sugeno inference model, Fuzzy C-Mean clustering with Turksen fuzzy regression/fuzzy function, fuzzy reinforcement learning, fuzzy support vector machines and fuzzy decision trees can be mentioned among the techniques used in these projects. In the same years, he supervised his doctoral students for their research questions. At the same time, he continued to make a strong contribution to

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the work of his former PhD students. His research interest in these years are; “objective function based interval valued fuzzy system modelling”, “fuzzy decision making”, “cluster validity index based on interval valued fuzzy logic”, “fuzzy feature selection”, “fuzzy functions”, “enhanced fuzzy clustering algorithms” and “fuzzy hybrid models”. Again we see that healthcare, finance, economy and industry problems are among the areas of application of his research. Dr. Turksen founded IIC - Information Intelligence Company in 2002 and took another step for university industry cooperation. These years were very fruitful and exciting for all of us who worked under his supervision.

He retired from the University of Toronto in 2003. However, he continued to teach at the University of Toronto as an emeritus professor and continued to work on several projects at the KIS laboratory. He joined the faculty of TOBB ETU as the founding chair of the Department of Industrial Engineering in 2005. The KIS laboratory at the University of Toronto continued to research and host the visiting researchers until the end of 2016.

Dr. Turksen has worked for more than 40 years developing Full Type 2 Fuzzy Logic, Fuzzy System Modelling, Objective Function Based Fuzzy Systems, Fuzzy Decisions, Hybrid Fuzzy Systems, Fuzzy Clustering Algorithms, and many more topics that I can not list here. He contributed the related literature in a way that many of us willing to do. He also taught and supervised many brilliant minds and has brought many scientists to the world and Turkey.

In this short time, I can give only a brief summary of some of Prof. Burhan's research. He has retired from his professional career but his contribution to the academy will always continue. Many of the works we have left behind will continue, his legacy will continue to grow with the scientists he brought to us. I have the honor of being his doctoral student and I feel privileged that I am the friend of one of the most creative, innovative and developing academics in this field; Prof. Burhan Turksen.

Interval Type-2 Fuzzy Cognitive Maps

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Abstract

The mathematical modeling of human cognitive processes has been one of the primary concerns of the artificial and computational intelligence research. Cognitive maps, which were developed in the mid-1970s for knowledge representation of the political elites, can be considered as the initial step toward this direction. Almost a decade later after the advent of the cognitive maps, fuzzy cognitive maps were proposed to cope with uncertain and imprecise knowledge. Fuzzy cognitive maps exhibit the desirable properties of artificial neural networks and fuzzy logic. When compared with the artificial neural networks, fuzzy cognitive maps are very easy to be interpreted. Additionally, concepts and connections have certain meanings in the fuzzy cognitive maps. In parallel with this, the relationships among system variables are not only described by sign, but their strengths are also examined by means of fuzzy sets. Linguistic variables such as low, medium, high, etc., are used to quantify the degree of causal relationships among the system variables. Application areas on which the fuzzy cognitive maps have demonstrated exceptional performance include decision making, control, pattern recognition, prediction and classification. Although the fuzzy cognitive maps have enjoyed a visible position in fuzzy modeling to date, concept values and the relationships among concepts are defuzzified and fuzzy singletons are used in the inference algorithm which consequently evokes undesirable information loss. Despite its crucial importance, fuzzy number representation in concept values and connection matrix is very little issued in the literature. In the pursuit of enhancing modeling capabilities of fuzzy cognitive maps, we have developed an inference algorithm in which both the input and output of the system are represented as fuzzy numbers. For that purpose, an alpha-cut based computational procedure has been proposed for type-1 fuzzy cognitive maps, and the proposed model is verified by using the extension principle. Then, natural generalization for the case of interval type-2 fuzzy sets has been given. In this talk, type-1 and interval type-2 fuzzy number representation in fuzzy cognitive maps will be discussed in terms of computational steps along with their interpretation.

Solving Second Order Intuitionistic Fuzzy Initial Value Problems with Heaviside Function

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Abstract

In this work we have firstly studied the properties of α and β cuts of intuitionistic fuzzy numbers. Then we investigate the solutions of intuitionistic fuzzy initial value problems for second order differential equations by using Zadeh's Extension Principle. Here, we extend the algorithm [1, 2] based on fuzzy initial value problems for 2nd order linear differential equations to intuitionistic fuzzy environment. We examine the solution of the following second order intuitionistic fuzzy initial value problem through Zadeh's Extension Principle for intuitionistic fuzzy sets [3]:

$$y''(x) + a_1 y'(x) + a_2 y(x) = \sum_{j=1}^r b_j^i g_j(x)$$
$$y(0) = \gamma_0^i$$
$$y'(0) = \gamma_1^i$$

Here a_1 and a_2 are crisp constants and g_j ($j = 1, \dots, r$) are continuous functions on the interval $[0, \infty)$. The initial conditions γ_0^i , γ_1^i and forcing coefficients b_j^i ($j = 1, \dots, r$) are intuitionistic fuzzy numbers.

Keywords: *Intuitionistic fuzzy sets, initial value problems, Zadeh's Extension Principle*

References

- [1] Akin, O., Khaniyev, T., Bayeg, S., Turksen, B. (2016). Solving a Second Order Fuzzy Initial Value Problem Using the Heaviside Function, Turkish Journal of Mathematics and Computer Science, V.4, 16-25.
- [2] Akin, O., Khaniyev, T., Oruc, O., Turksen, I.B. (2016). Some Possible Fuzzy Solutions for Second Order Fuzzy Initial Value Problems Involving Forcing Terms, App. Comput. Math., V. 13, N. 2, 16-25.
- [3] L. Atanassova, On Intuitionistic Fuzzy Versions of L. Zadeh's Extension Principle, NIFS, V.13, 2007, pp. 33–36.

A Membership Value Based Performance Measure

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Abstract

Different models based on fuzzy logic theory have been widely used in many application areas including but not limited to forecasting, optimization, clustering, and modeling. Evaluating the performance of these models is a crucial and challenging task. A performance measure calculated based on the difference between the defuzzified output values and corresponding desired values is generally preferred. Although fuzzy inference is performed over fuzzy sets or numbers, performance measure is generally calculated over numerical values in the literature. Therefore, the membership values are ignored. Aladag and Turksen (2015) proposed a performance measure in order to take membership values into account during the evaluation process. When this membership value based performance measure is used, memberships values are embodied in the evaluation process.

A Tool for Calculating Fuzzy and Interval Production Loss Measurements

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Abstract

Overall equipment effectiveness (OEE) is one of the most used key performance indicators in manufacturing systems. It unifies three different components, namely availability, performance and quality, to one value which increases the usability of OEE (Nakajima, 1988). These components are obtained from production losses, accuracy of which effect the OEE indicator. Furthermore, production losses are calculated by using the measurements of total stoppage duration, production speed and nonconforming production amount. Since uncertainty is an unavoidable part of such manufacturing systems, calculation methods of these production losses should be able to handle different types of uncertainties (Sönmez and Testik, 2015). Due to mathematical difficulties of calculation methods that handle uncertainty, practitioners need tools to ease calculations. In this study, uncertainties are characterized as fuzzy or interval type measurements. Calculation methods for production losses are explained first and a software developed to overcome the mathematical complexity of calculations is introduced. The generality and usability of the tool is finally illustrated by using real world data gathered from PVC extrusion lines.

Keywords: *Production Losses, Fuzzy Logic, Interval Analysis, Performance Measurement*

References

- [1] Nakajima, S. (1988). Introduction to TPM: Total Productive Maintenance. Productivity Press, Inc.
- [2] Sönmez, V. and Testik, Ö. M. (2015). Modeling Uncertainty in Operators' Statements in Measuring the Performance of a Continuous Production Line, The 4th International Fuzzy Systems Symposium (FUZZYSS'15), İstanbul/TURKEY, November 5–6.

A Systematic Approach for Building and Analyzing Problem Solving Networks in Open Innovation

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Abstract

Open innovation refers to inward and outward flow of new ideas and new knowledge in an organization (Chesbrough, 2006). This innovation approach is adopted by more companies each day as it enabled them span their boundaries in both creating and commercializing innovations (West et al., 2014). Innovation is a comprehensive concept involving new products as well as processes. Open process innovation involves new or significantly improved ways of solving process related problems using open innovation principles. In any company various technical, managerial, organizational, process-related and product-related problems are faced and to solve these problems usually a cooperative work of more than one person is needed. Problem solving networks in an organization may include not only internal stakeholders but also external players (Felin and Zenger, 2014). In this study, the concept of open innovation has been discussed in terms of process innovation and a systematic approach for building and analyzing problem solving networks in open innovation is proposed. The proposed approach is illustrated with an application in a firm operating in prepress preparation sector. Data was collected using a questionnaire and a visual form developed for this study and analysis of data was performed using network analysis and fuzzy cognitive mapping methods. First, a questionnaire was developed to find out the existence of the firm's open innovation tendency in order to solve the problems. Later, network analysis was conducted by collecting data with the visual inter-source communication form created to find out who are involved in problem solving, quality of their communication and their re-communication status. Then, cognitive mapping method was used to examine the relations in the network.

Keywords: *Open innovation, Problem solving, Network analysis, Fuzzy cognitive mapping*

References

- [1] Chesbrough, H.W. (2006). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, Massachusetts: Harvard Business School Press.
- [2] West, J., Salter, A., Vanhaverbeke, W. and Chesbrough, H. (2014) *Open Innovation: The Next Decade*. *Research Policy*, 43, 805–811.
- [3] Felin T. and Zenger, T.R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, 43, pp. 914-925.

A Note on 2-Absorbing Primary Fuzzy Ideals

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Abstract

The purpose of this study to define 2-absorbing fuzzy ideals and 2-absorbing primary fuzzy ideals which are generalizations of prime fuzzy ideals and primary fuzzy ideals. Also relations between 2-absorbing (primary) fuzzy ideals and 2-absorbing (primary) ideals are analyzed . Furthermore we investigate image and inverse image of 2-absorbing primary fuzzy ideals. Finally, transition between definitions of fuzzy ideals is viewed.

Keywords: 2-absorbing fuzzy ideals, 2-absorbing primary fuzzy ideals

References

- [1] Badawi, “On 2-absorbing ideals of commutative rings,” Bulletin of the Australian Mathematical Society, vol. 75, no. 3, pp. 417–429, 2007.
- [2] Badawi, U. Tekir, and E. Yetkin, “On 2-absorbing primary ideals in commutative rings,” Bulletin of the Korean Mathematical Society, vol. 51, no. 4, pp. 1163–1173, 2014.
- [3] V. N. Dixit, R. Kumar, and N. Ajmal, “Fuzzy ideals and fuzzy prime ideals of a ring,” Fuzzy Sets and Systems, vol. 44, no. 1, pp. 127–138, 1991.
- [4] W. J. Liu, “Fuzzy invariant subgroups and fuzzy ideals,” Fuzzy Sets and Systems, vol. 8, no. 2, pp. 133–139, 1982. T. K. Mukherjee and M. K. Sen, “Prime fuzzy ideals in rings,” Fuzzy Sets and Systems, vol. 32, no. 3, pp. 337–341, 1989.
- [5] T. K. Mukherjee and M. K. Sen, “Primary fuzzy ideals and radical of fuzzy ideals,” Fuzzy Sets and Systems, vol. 56, no. 1, pp. 97–101, 1993.
- [6] F. I. Sidky and S. A. Khatib, “Nil radical of fuzzy ideal,” Fuzzy Sets and Systems, vol. 47, no. 1, pp. 117–120, 1992.
- [7] D. Sönmez, G. Yeşilot, S. Onar, B.A. Ersoy, and B. Davvaz, “On 2-Absorbing Primary Fuzzy Ideals of Commutative Rings,” Math. Prob. in Eng., vol. 2017, 7, 2017.
- [8] L. A. Zadeh, “Fuzzy sets,” Information and Control, vol. 8, no. 3, pp. 338–353, 1965.

Choosing Fuzzy Operators for Real-life Engineering Applications

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Abstract

This work is induced and inspired by the initial domain engineering activities of our ongoing project on model-driven software development automation that aims using fuzzy inference methods for a design and programming environment that is expected to provide intelligent guidance for software development. Software engineering domain contains uncertainty and imprecision that intrinsically bring about the use of fuzzy values. However the complexity and abstract nature of the concepts and decisions of the engineering domain often renders classical fuzzy logic insufficient. When the conventional fuzzy logic approach is found not to be appropriate for a certain task, switching to a more suitable t-norm/t-conorm function pair is a challenge. In some cases it may even be a necessity to extend the existing framework of fuzzy logic with other forms of knowledge representation. In this work we attempt to provide a geometrical semantics for the three common t-norm functions in order to put theory and practice into a common perspective. Probability, distance, aggregation and other semantic metaphors are also assessed via direct practical considerations. Our work that aims faithful representation of concepts and reliable decision taking processes is hoped to contribute to the generality and scalability of fuzzy programming.

Keywords: *Fuzzy logic, Fuzzy Sets, Semantics, Engineering*

References

- [1] Belohlavek, R., Klir, G.J., Lewis, H.W., Way, E.C..(2009). Concepts and fuzzy sets: Misunderstandings, misconceptions and oversights. *International Journal of Approximate Reasoning*, 51(3), 23.-34.
- [2] Weigert, T.J., Tsai, J.P., Liu, X..(1991). Fuzzy operator logic and fuzzy resolution. *Journal of Automated Reasoning*, 10(1), 59.-78.
- [3] Osherson, D.N., Smith, E.E..(1981). On the adequacy of prototype theory as a theory of concepts. *Cognition*, 9(1), 35.-58.
- [4] Reed, S.K..(1972). Pattern recognition and categorization. *Cognitive Psychology*, 3(3), 382.-407.

Fuzzy Logic Based Decision Making and Risc Analysis Approach for Railway Inspection

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Abstract

Railway lines, which are part of railway transport systems, need to be periodically inspected and maintained. Intelligent systems that use machine learning algorithms based on computer vision are currently used to detect rail faults. These methods are effective in detecting rail failures, risk analysis is made and the need for specialist in taking operational decisions causes time and cost loss. Another disadvantage is that expert knowledge is limited to the abilities of the subject and the expert. Many factors such as the number of failures, type, number, frequency, size, etc., as well as the detection of faults in a railway line are necessary for risk analysis and maintenance decision. The first aim of this study is to apply a fuzzy decision-making approach that uses the above-mentioned diagnostic results as an input after the rail inspection process. The second aim of the study is to determine the level of railway risk analysis based on fuzzy logic. Based on the proposed approach, big data based processing of data such as rail image, ultrasonic data, video, three-dimensional laser camera, training, diagnosis results are obtained and fuzzy classification is done on these results in the last step to determine the fuzzy risk level and determination of the fuzzy decision making mechanism it covers. Nowadays, fuzzy logic is successfully applied in railway transportation systems in acceleration, braking controls and reducing energy costs of railway vehicles. By adopting the proposed approach, railway rail inspection applications will be made an important contribution to rail analysis studies and will provide time and cost savings as risk level determination and decision maker. The system has been trained, tested and validated with the results obtained using the data obtained from a ray track with the purpose of verifying the presented work.

Keywords: *Big Data, Fuzzy system, Rail Inspection, Railway Risk Analysis.*

References

- [1] An, M., Chen, Y., Baker, C. J. (2011). A fuzzy reasoning and fuzzy-analytical hierarchy process based approach to the process of railway risk information: A railway risk management system. *Information Sciences*, 181(18), 3946-3966.
- [2] Skarlatos, D., Karakasis, K., Trochidis, A. (2004). Railway wheel fault diagnosis using a fuzzy-logic method. *Applied Acoustics*, 65(10), 951-966.
- [3] Cao, B., Ding, Y., Zhao, H., & Song, Y. (2016). Damage identification for high-speed railway truss arch bridge using fuzzy clustering analysis. *Structural Monitoring and Maintenance*, 3(4), 315-333.

Hierarchical Fuzzy System Based Classification Approach for Railway Components Using Vision Inspection

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Abstract

Railway transportation has been widespread in recent years by using developing technologies. Monitoring of railway components with non-contact image processing techniques increases the quality of transportation. In this study, inspection of turnouts, level crossings, fasteners and traverses from rail track components were done using image processing and hierarchical fuzzy system. The hierarchical fuzzy system is used to reduce the amount of fuzzy rules and reduce the parameters used in the classification process [1,2]. The areas where the connecting elements, switch crossings, level crossings and sleepers are located in the railway input image taken from the camera are determined. After a number of image processing techniques, the pixel density in the image, the number of lines in pixels, the area covered by pixels, the coordinate information of the region with pixel density, the number of ellipses in the image, and the positional information of these ellipses are used to classify the rail line components. The hierarchical fuzzy system has been used to classify instead of using these features as input by removing these features. After these features are extracted in image by image processing techniques [3], the number of lines in the image and the number of ellipses in the image are firstly given as inputs to the hierarchical fuzzy system. We have continued to classify the output obtained by the hierarchical fuzzy system by considering the position of the ellipse and the number of pixels covered of the ellipse. So that the region where the fasteners are located is determined. The classification process has been continued taking into consideration the result obtained from this, the area covered by the line and the pixel density. The hierarchical fuzzy system enables classification of rail, sleeper, turnout, and level crossing by taking into account the slope angle and the number of lines in the image. The image position of the classified rail track objects can thus be determined more easily. This study has been supported by TUBITAK (The Scientific and Technological Research Council of Turkey). Project Number: 114E202.

Keywords: *Railway components, Hierarchical fuzzy system, Image processing, Classification*

References

- [1] Zhang, X., Onieva, E., Perallos, A., Osaba, E., Lee, V. C. (2014). Hierarchical fuzzy rule-based system optimized with genetic algorithms for short term traffic congestion prediction. *Transportation Research Part C: Emerging Technologies*, 43, 127-142.
- [2] Sun, L., Huo, W. (2016). Adaptive fuzzy control of spacecraft proximity operations using hierarchical fuzzy systems. *IEEE/ASME Trans. on Mechat.*, 21(3), 1629-1640.
- [3] Taştımur, C., Karaköse, M., Akin, E. (2016). A Vision Based Condition Monitoring Approach for Rail Switch and Level Crossing using Hierarchical SVM in Railways. *International Journal of Applied Mathematics, Electronics and Computers*, 4, 319-325.

Selection of Urban Rail Transport Type by Using Fuzzy AHP

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Abstract

One of the most important issues of growing and developing cities is urban transport. Public transportation is encouraged in order to improve the urban transportation and decrease the waste of time in the traffic, and investments are made on this area. In this context, the managers are focusing on rail system investments that is in safe, fast and high capacity. Transportation systems can increase the productivity and quality of life at the same time if they are planned and managed properly [1]. It is important for the sustainability of urban transport to be select the most appropriate among diversified systems as subway, light rail, monorail and tramway rail systems. Various factors such as social, economic and technical criteria are taken into account by managers and included in the assessment at the point of ensuring sustainability [2]. In this study, fuzzy analytic hierarchy process (FAHP) was used to select the rail transportation system that could improve the urban transportation. Analytic hierarchy process is the analytical decision-making process based on pairwise comparison. In the decision process, fuzzy numbers were used to figure the linguistic expressions the most appropriately as mathematically [3]. As a result, the most suitable mode of transportation was selected for urban transportation.

Keywords: FAHP, Public transport, Urban Transport, Rail systems

References

- [1] Tuzkaya, U. R. (2009). Evaluating the environmental effects of transportation modes using an integrated methodology and an application. *International Journal of Environmental Science & Technology*, 6(2), 277-290.
- [2] Şengül, Ü., Miraç, E., & Shiraz, S. E. (2012). Bulanık AHP ile belediyelerin toplu taşıma araç seçimi. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, (40), 143-165.
- [3] Tuzkaya, U. R., & Önüt, S. (2008). A fuzzy analytic network process based approach to transportation-mode selection between Turkey and Germany: A case study. *Information Sciences*, 178(15), 3133-3146.

A Method of Using Fuzzy Decision Trees for Fault Diagnosis of Pantograph-Catenary Systems

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Abstract

There are many different faults in the railway system. The main ones are rail failures, structural failures of the train, and malfunctions in the engine system, transmission failures and catenary failures. The failures that can occur especially in the catenary and pantograph sections in these defects directly affect the movement of the trains and thus necessitate studying and providing early diagnosis [1]. Early diagnosis of failures in these systems will also ensure that care plans are planned to provide more regular and effective results. In this study, it is aimed to determine the failures that can occur in this system especially considering the direction of the railway system and it is aimed to establish the information system in advance. First of all, pantograph is detected. Images taken for this purpose are used. The images is scanned with the previously created pantograph mask and the area in which the overlapped images are provided is accepted as a pantograph. In order to achieve this acceptance, a similarity rate of 85% has been adopted and transactions have been carried out accordingly. The point where the detected pantograph joins with the catenary is detected in the next step. Because of the determinations made, the point where the catenary and the pantograph join is observed. The arcs that can occur during this observation are determined and the condition of the arc according to the size of these arcs is determined. During the calculations, the arcs covers the area of the pixel and the location of the view. Inputs and outputs of this system are obtained with fuzzy decision trees. The use of fuzzy structure prevents you from deciding the exact dimensions of arcs [2]. An arc can represent both a possible condition and a minor fault condition. Therefore, it is desired to make this system more effective and provide a probable result with the fuzzy structure. Obtained results; no faults, low risk failure does not require immediate intervention, medium risk fault requires intervention in a short time, and high risk fault is determined as failure requiring immediate intervention. These results are transmitted to planning centers via wireless network. In accordance with the situation of the fault, it is ensured that the intervention plan is made and the actual fault is eliminated.

Keywords: *Railway, Head System, Fuzzy decision tree, Fault Detection.*

References

- [1] Barmada, S., Raugi, M., Tucci, M., & Romano, F. (2013). Arc detection in pantograph-catenary systems by the use of support vector machines-based classification. *IET Electrical Systems in Transportation*, 4(2), 45-52.
- [2] Yang, B. S., Oh, M. S., and Tan, A. C. C. (2009). Fault diagnosis of induction motor based on decision trees and adaptive neuro-fuzzy inference. *Expert Systems with Applications*, 36(2), 1840-1849.

Hesitant Fuzzy Linguistic COPRAS Method for Marketing Strategy Selection

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Abstract

Marketing strategies are very important for a company to be successful. Nowadays, marketing approaches are very customer-focused and products are oriented to satisfy customer needs. Products gain value in order to find new markets and the purpose of marketing is to create an efficient process. At this point, companies are forced to use correct marketing strategies to differentiate themselves from their competitors and to provide the best customer satisfaction. Selecting the right marketing strategies will decrease companies' costs, increase customer satisfaction and improve the competitive capacity [1]. Considering the complex profile of the marketing strategy selection problem involving many conflicting objectives, different criteria need to be taken into account by experts for deciding on the suitable strategy. However, it is difficult to decide on and select the winning strategy when information is in uncertain nature. For this reason, hesitant fuzzy linguistic term set (HFLTS) approach is implemented to overcome the hesitation and uncertainty of this decision-making problem [2]. The purpose of this paper is to propose an integrated hesitant fuzzy linguistic (HFL) multi-criteria decision-making (MCDM) approach to select the most suitable marketing strategy for companies. In the first phase of the study, HFL Simple Additive Weighting (SAW) method is applied for calculating the criteria weights [3]. In the second phase, the best marketing strategy is selected with the HFL complex proportional assessment (COPRAS) method [4]. This study proposes the company's marketing strategy selection as an MCDM problem and presents a selective approach to solve it with integrated hesitant fuzzy linguistic methods. This study can be useful for companies to better understand marketing strategy selection problems theoretically and apply satisfying marketing strategy evaluation systems. Finally, a case study is provided in order to demonstrate the potential of the proposed approach.

Keywords: *Hesitant Fuzzy Linguistic COPRAS, Hesitant Fuzzy Linguistic Term Sets, Marketing strategy selection., Multi criteria decision making*

References

- [1] Zahay, D., Griffin, A. (2010). Marketing strategy selection, marketing metrics, and firm performance. *Journal of Business & Industrial Marketing*, 25(2), 84-93.
- [2] Rodriguez, R. M., Martinez, L., Herrera, F. (2012). Hesitant fuzzy linguistic term sets for decision making. *IEEE Transactions on Fuzzy Systems*, 20(1), 109-119.
- [3] Chou, S. Y., Chang, Y. H., Shen, C. Y. (2008). A fuzzy simple additive weighting system under group decision-making for facility location selection with objective/subjective attributes. *European J. of Operational Research*, 189(1), 132-145.
- [4] Fouladgar, M. M., Yazdani-Chamzini, A., Lashgari, A., Zavadskas, E. K., Turskis, Z. (2012). Maintenance strategy selection using AHP and COPRAS under fuzzy environment. *International journal of strategic property management*, 16(1), 85-104.

Interval Valued Hesitant Fuzzy Analytic Hierarchy Process and Its Application to Group Decision Making

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Abstract

In a multi-criteria decision making methods (MCDM) various techniques have been developed. Analytic Hierarchy Process (AHP) method has attracted the interest of many researchers mainly because it is one of the most powerful synthesis methodologies for ranking options and predicting outputs effectively with combining opinions and data. Fuzzy sets and its extensions frequently used for the solution of decision-making problems. These extensions are used for better defining the membership values of the problem criteria. One of these extensions is the Interval-valued Hesitant Fuzzy Sets (IVHFS) that are used for defining uncertain evaluation information in group decision making (GDM) processes. It provides all possible interval values for decision makers that are not able to be explained with other types of fuzzy sets and extensions. In this research, a new AHP method based on IVHFS has been developed. The developed Interval Valued Hesitant Analytic Hierarchy Process has been applied to a supplier selection problem. In addition, numerical example has been provided to illustrate the proposed approach and its steps.

Keywords: *Group decision making, Interval-valued hesitant fuzzy sets, AHP, Supplier selection*

References

- [1] Oztaysi.B, Cevik Onar. S, Bolturk. E, Kahraman.C, (2015) Hesitant Fuzzy Analytic Hierarchy Process. International Conference on Fuzzy Systems (FUZZ-IEEE 2015), Istanbul, Turkey.
- [2] Chen.N, Xu.Z, Xia.M, (2013), Interval-valued hesitant preference relations and their applications to group decision making, Knowledge-Based System, 37, 528-540.
- [3] Tavakoli-Moghadam.R, Gitinavard. H, Mousavi S.M, Siadat, (2015) An Interval-Valued Hesitant Fuzzy TOPSIS Method to Determine the Criteria Weights, Outlooks and Insights on Group Decision and Negotiation, Volume 218, 157-163.
- [4] Wu. J, Huang. H, Cao. Q, (2013) Research on AHP with interval-valued intuitionistic fuzzy sets and its application in multi-criteria decision making, Applied Mathematical Modeling, Volume37 (Issue 24), 9898-9906.

A Fuzzy Decision System for Car Fault Diagnosis Using Vibration Data

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Abstract

The importance of smart cities has been getting increase due to their popular applications for last decade, which are focused on fields of energy, communication, transportation and human life. Intelligent system applications, especially in transportation, are among the factors affecting people's life and their private security. Due to such reasons, many studies have been performed in this area [1-3]. Hence, the focus of this work is on automobiles. Diagnosis of some failures in automobiles, and making the necessary repair plans may increase the comfort and safety of people before a trip. This work aims to detect possible engine malfunctions and tire balancing faults in automobiles. In order to perform such detection operations, vibration data from the automobile is used. For this reason, a car with a malfunctioning car and a car with balancing faults are taken. The smartphone sensors are used to retrieve necessary data. Data are acquired by stationary car while the motor runs idle, and by the moving car at different speeds. The system is designed so that the results are employed as input into the Fuzzy decision system and consequently results in faulty motor, faulty balance, and faulty both motor and balance. Standard and low level vibration data are obtained by the data taken from the automobile without malfunction. The car data is taken from the car in which the engine was faulty, and it was observed that there were continuous and normal vibrations. In the case of a balancing fault, when the car was stationary, vibrations that did not indicate a standard failure were seen. Then the car was moved at a specified speed for a certain period of time; under this condition, vibration was observed at different speeds. Observation of this situation has resulted in tire malfunction of the car. Finally, both the engine malfunction and the balance malfunction were handled. In this automobile, vibrations were obtained above normal level while both it is stationary, motor runs idle; and moving. Also, as the speed was increased, the vibration level was observed to increase. Thus, two types of car faults have been identified by the vibration data. In this endeavor, a warning is issued to prevent further malfunctions in automobile and to prevent loss of life. Consequently, it is recommended to be carried out necessary repairs right away.

Keywords: *Fault Detection, Intelligent Vehicle, Smartphone, Sensors.*

References

- [1] Last, F. M. Wang, R., and Wang, J. (2011). Fault-tolerant control with active fault diagnosis for four-wheel independently driven electric ground vehicles. IEEE Transactions on Vehicular Technology, 60(9), 4276-4287.

A Methodology for Analytic Customer Relationship Management: Integration Of Intuitionistic Fuzzy ELECTRE and VIKOR

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Abstract

Customer reviews are of great importance for both potential customers and companies, since they have a significant impact on purchase decisions. Sentiment analysis is utilized to extract information about customer satisfaction on products from large amount of online reviews automatically. Multi criteria decision making (MCDM) methodologies can be used to rank the products considering the information extracted by sentiment analysis and identify the best one among a set of products. This study develops a methodology using MCDM based on intuitionistic fuzzy sets (IFS) theory for analytic customer relationship management. More specifically ELECTRE and VIKOR methods are integrated under intuitionistic fuzzy environment. The study uses the inputs gathered from sentiment analysis results which indicate customer satisfaction about the alternative products. The methodology is facilitated in ranking alternative products considering the relative importance of different properties of the product for a consumer and the best alternative is selected. We have utilized two methods [1, 2] in developing the proposed integrated methodology. In order to benefit from the similarity of the concordance and discordance characteristics of ELECTRE with minimum individual regret and maximum group utility characteristics of VIKOR, these methods are integrated. Furthermore, ELECTRE has a good performance on pairwise comparison and it is good at choosing the best alternative, on the other hand VIKOR has an advantage in terms of ranking the alternatives. The methodology includes intuitionistic fuzzy numbers with the purpose of expressing the hesitation and uncertain situations since ignoring hesitant expressions can cause the lack of information. The methodology is applied on the tourism sector, to rank five hotels in Çeşme/İzmir considering the comments on otelpuan.com made by the customers. In addition, sensitivity analysis is conducted to reveal the impact of different weights of criteria on the results. To the best of our knowledge, this study is the first attempt to integrate ELECTRE and VIKOR under IFS theory. It is also the first study that integrates sentiment classification and MCDM to analyze online reviews in Turkish. Although it is applied to the hotel case in our study, the developed methodology can be employed to other cases to rank products in different sectors. Potential customers will be able to utilize from the methodology in analyzing online product comments, and in selecting the most appropriate alternative practically and reliably.

Keywords: *Multi criteria decision making, Sentiment analysis, Product ranking*

References

- [1] Zandi, A., Roghanian, E. (2013). Extension of Fuzzy ELECTRE based on VIKOR method. *Computers & Industrial Engineering*, 66(2) 258-263.
- [2] Wu, M.-C., Chen, T.-Y. (2011). The ELECTRE multicriteria analysis approach based on Atanassov's intuitionistic fuzzy sets. *Expert Sys. with App.*, 38(10) 12318-12327

A Higher Order Fuzzy Lee-Carter Method for Modeling Human Migration

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Abstract

Migration modeling and forecasting are important research areas since migration rates and flows are vital demographic indicators in population dynamics. Constructing well defined migration models with high estimation capabilities is crucial for future population forecasts as well as socio-economic policy designs, security issues and decision making in private and public investments [1]. The complex nonlinear characteristics of migration phenomenon, and the complicated strict statistical assumptions that the existing migration modeling approaches rely on make it difficult to estimate migration rates based on past data [2]. Considering these, in this study, a fuzzy method is proposed to model age specific net migration rates. The proposed method is an extension of the existing fuzzy Lee-Carter (LC) [3] model originally developed for mortality modeling, and it incorporates higher order singular value decomposition (SVD) technique and fuzzy regression with minimum fuzziness criterion. The inclusion of higher order singular values enables the model to capture the fluctuations in migration patterns more accurately. As well as this, with the fuzzy structure of the method, the homoscedasticity assumption of the original LC model, which indicates that the demographic rates for all age cohorts are normally distributed with a single constant variance, is eliminated. Furthermore, the ambiguities in migration data due to data collection and recording errors as well as the vagueness as a result of the lack of a universally accepted “migrant” definition can be handled via the fuzzy concept of the proposed method. The proposed method is applied on estimated net-migration data of Poland for ages 0 to 64 between years 1990 to 2013. The results display that the capability of the method in generating better fits to the estimated net migration data improves as the order of the SVD increases.

Keywords: *Fuzzy regression, singular value decomposition, demographic modeling, migration analysis*

References

- [1] Bijak, J. (2011) Forecasting International Migration in Europe: A Bayesian View (1st ed.). New York, the USA: Springer.
- [2] Wisniowski, A., Smith, P.W.F., Bijak, J., Raymer, J., Forster, J.J. (2015). Bayesian population forecasting: Extending the Lee-Carter method. *Demography*, 52(3), 1035-1059.
- [3] Koissi, M.C., Shapiro, A.F. (2006). Fuzzy formulation of Lee-Carter model for mortality forecasting. *Insurance: Mathematics and Economics*, 39, 287-309.

Determining Market Strategy by Using a Fuzzy Rule Based Algorithm

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Abstract

Progressing of technology and changes in customer demands have brought about various changes in field of marketing. In addition, expectation of each generation from brands or firms has been also different. People benefit from different sources to select and evaluate product they need among many alternative products. Customers try to opt for products which satisfy their requirements at the highest level in comparison process. Marketing mix created by enterprises that spend their operating assets to respond to wishes and expectations of consumers should not damage to enterprises' economy. For this reason, enterprises need to consider certain criteria to determine the type of product or service they will produce and the target group they will present their products/services to. In this study, fuzzy logic approach has been applied in order to determine marketing strategy which should be preferred by enterprises, considering different criteria. For fuzzy-based algorithm developed, growth strategy of rival company, customer requirements, product life cycle, product type, product homogeneity, operating assets were used as model inputs and target market strategy which should be chosen by firm was used as model outputs. Fuzzy decision rules created by evaluation of five different experts from two different work areas were added to model with the help of "Fuzzy Logic Designer" module of Matlab2009a package program. In result of implementation, developed algorithm offer advisory results which include strategies that should be followed under different circumstances by enterprises.

Keywords: *Fuzzy Logic, Fuzzy Controller, Marketing Strategy*

References

- [1] Li, S. (2000). The development of a hybrid intelligent system for developing marketing strategy. *Decision Support Systems*, 27(4), 395-409.
- [2] Li, S., Davies, B., Edwards, J., Kinman, R., Duan, Y. (2002). Integrating group Delphi, fuzzy logic and expert systems for marketing strategy development: the hybridisation and its effectiveness. *Marketing Intelligence & Planning*, 20(5), 273-284.
- [3] Ahmad, F., Khan, A. A., Baig, M. M. (2017). Weighting of Marketing Mix Elements Using Fuzzy Analytic Hierarchy Process and Area Based Ranking of Fuzzy Numbers. *Ned University Journal of Research*, 15(2).

Numerical Solutions of Aggregation Processes Based on Fuzzy Markov Chains

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Abstract

Population Balance Equations (PBEs) are very powerful tool in order to analyze particulate processes. Comprehensive numerical solution techniques often accompany with the developed PBEs due to the intrinsically complex analytical solutions. In this study, the fuzzy Markov chain method is proposed as a new discrete solution of a population balance equation for an aggregation process aiming to determine the particle size distribution (PSD) over time. Analytical solution of a case study of the aggregation equation is compared with the fuzzy Markov chain method for the constant aggregation kernel. Simulation results show that if the size range of the system is divided into a sufficient number of states and an appropriate transition time step is chosen then the results obtained from the fuzzy Markov chain method are in a good agreement with the analytical solutions of PBEs governed by same aggregation kernel and with same initial PSD.

Keywords: *Mathematical modeling, Fuzzy Markov chains, Aggregation*

References

- [1] Berthiaux, H. and Mizonov, V. (2004). Applications of Markov chains in particulate process engineering: a review. *The Canadian Journal of Chemical Engineering*, 82(6), 1143-1168.
- [2] Farina, L. and Rinaldi, S. (2011). *Positive linear systems: theory and applications* (Vol. 50). John Wiley & Sons.
- [3] Gelbard, F. and Seinfeld, J. H. (1980). Simulation of multicomponent aerosol dynamics. *Journal of colloid and Interface Science*, 78(2), 485-501.
- [4] Hill, P. J. and Ng, K. M. (1996). New discretization procedure for the agglomeration equation. *AIChE Journal*, 42(3), 727-741.

A Comparison Study of Fuzzy Logistic Regression Models with Different Criteria

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Abstract

It is difficult to model the systems in which, human thought and experience is effective. Fuzzy set theory proposed by Zadeh in 60's is successful at identifying and modelling these models. Fuzzy logistic regression analysis is a regression method, based on fuzzy set theory, used in situations where the assumptions of classical logistic regression analysis cannot be fulfilled or being fuzzy due to nature of data. The aim of this paper is to compare fuzzy logistic regression models proposed by Pourahmad et. al(2011) and Atalik and Şentürk (2017) and to determine the best model by the aid of different performance criteria. It is seen that the model proposed by Atalik and Şentürk (2017) is better than the other model according to MDM criteria.

Keywords: Fuzzy Logistic Regression, MDM Criteria, MSE criteria

References

- [1] Atalik G. and Şentürk S. (Article in Press) A New Approach for Parameter Estimation in Fuzzy Logistic Regression, Iranian Journal of Fuzzy Systems, http://ijfs.usb.ac.ir/article_3271.html
- [2] Pourahmad, S., Ayatollahi, S. M. and Taheri, S. M. (2011). Fuzzy Logistic Regression: A New Possibilistic Model and Its Application In Clinical Vague Status. Iranian Journal of Fuzzy Systems, 8(1), 1-17.
- [3] Zadeh, L. A. (1965). Fuzzy Sets. Information and Control, 8, 338-353.
- [4] Pourahmad, S., Ayatollahi, S. M., and Taheri, S. M. (2011). Fuzzy Logistic Regression Based on the Least Squares Approach with Application in Clinical Studies. Computers and Mathematics with Applications (62), 3353-3365.
- [5] Hosmer, D. W. and Lemeshow, S. (2000). Applied Logistic Regression (Second Edition ed.). New York: John Wiley&Sons Inc.

Municipal Solid Waste Management with Cost Minimization and Emission Control Objectives

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Abstract

Municipal solid waste management (MSWM) is a critical aspect of every society which should be managed properly in order to preserve the resources and protect the environment. Frequently, waste management activities have focused on cost minimization goals. However, transportation is one of the integral parts of this system which produces huge amounts of greenhouse gas (GHG) emissions. Therefore, managing the system based on GHG minimization goal is crucial for the environment. In this study, we focus on bi-objective municipal solid waste management problem to locate collection stations and find the best pattern for waste flows while minimizing system's cost and GHG emissions from transportation. We assume that the amount of GHG emissions is proportional to fuel consumption which is calculated using the Comprehensive Modal Emission Model (CMEM). Epsilon-constraint method is implemented to generate Pareto front and find the best solution based on different perspectives. On top of that, driver's behavior is modeled by using fuzzy sets. The α -cut concept is employed to solve the model and investigate effect of the driver's behavior on GHG emissions.

Keywords: *Environment, GHG emissions, Bi-objective optimization, Fuzzy*

References

- [1] Ghiani, G., Laganà, D., Manni, E., Musmanno, R., Vigo, D. (2014). Operations research in solid waste management: A survey of strategic and tactical issues. *Computers & Operations Research*, 44, 22-32.
- [2] Badran, M. F., El-Haggar, S. M. (2006). Optimization of municipal solid waste management in Port Said–Egypt. *Waste Management*, 26(5), 534-545.
- [3] Demir, E., Bektaş, T., Laporte, G. (2011). A comparative analysis of several vehicle emission models for road freight transportation. *Transportation Research Part D: Transport and Environment*, 16(5), 347-357.
- [4] Ross, T. J. (2009). *Fuzzy logic with engineering applications*. John Wiley & Sons.

A Fuzzy Integration Approach for Feature Extraction Techniques in Image Processing Based Quality Control Applications

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Abstract

Lately human control has been inadequate for accelerating production and for identifying possible defects on products. For this reason, machine vision based quality control methods are increasing day by day. With the processing of images obtained by monitoring products with one or more cameras, many defects on the product are detected with high performance and high speed. In this case, the performance of feature extraction techniques, which are especially important for image processing, comes to the forefront. There are dozens of feature extraction techniques used for various purposes in the literature. However, these feature extraction techniques which is the main component of the image processing steps, perform well in certain conditions while others perform well in other condition. In this work, we propose an approach that uses fuzzy integral to combine the performance of feature extraction techniques grouped by the same objective and to convert it into a structure that provides high performance in all conditions. For this purpose, a fuzzy set in determines a fuzzy significance level are used each feature extraction technique in the group. Outputs of feature extraction techniques are combined according to the selected fuzzy integral algorithm according to these significance scores. In the scope of the study, the application structure and data required for image quality control based on the products have been verified. It is shown with comparative results that the performance of the proposed method is better than the each other feature extraction techniques. This study has been supported by Turkey Ministry of Science, Industry and Technology (SANTEZ Programme) under Research Project No: 0743.STZ.2014 (TUBITAK Grant No:112D021).

Keywords: *Fuzzy integral, Feature extraction, Image processing, Quality control.*

References

- [1] Weilin Wang, Changying Li, A multimodal machine vision system for quality inspection of onions, Elsevier, Journal of Food Engineering, vol. 166, 291–301, 2015.
- [2] Liang Xu, Xiaomin He, Xiuxi Li, Ming Pan, A machine-vision inspection system for conveying attitudes of columnar objects in packing processes, Elsevier, Measurement, vol. 87, 255–273, 2016.

A Fuzzy Optimization Framework for Design of Bio-Waste Based Energy Supply Chains

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Abstract

Various waste to energy supply chains are operated throughout the world, consisting of different biomass production systems, pre-processing and conversion operations, as well as transportation methods for raw materials and bio-based fuels. However, the wide use of biomass based energy systems has resulted in new challenges, such as: long-distance transport and therefore additional logistics costs, energy consumption and ultimately higher greenhouse gas (GHG) emissions compared to small-scale utilization. In many cases feedstock location, processing sites and product destinations have profound implications for the profitability and environmental impacts of the overall supply chain. To overcome these challenges, proper methodologies need to be developed to select the most favorable supply chain configuration and logistics options and to identify cost-efficient bioenergy supply chain designs with minimal carbon footprint. Most of the prior studies in the literature such that [1] and [2] that develop design methodologies by simultaneously considering sustainability and uncertainty aspects, capture these aspects by using separate methods after the design phase. We argue that it is important to develop and use an effective optimization methodology to capture both sustainability aspects and uncertainties in the system parameters in the same optimization framework in the design phase. This study develops a novel methodology, which could optimize multi waste supply chains including multiple types of production technologies considering circular economy principles, for the strategic and tactical decision making in waste biomass based energy production system investments. Using fuzzy multi objective programming, the proposed methodology finds the optimal supply chain configuration, selects the most appropriate production technologies and plans production/distribution activities that enables to meet the demand of multiple types of bio-products in a region considering a diversified set of available waste feedstock and technology options. The proposed approach enhances the capital investment and technology management decisions for planning a waste biomass based system by identifying the optimal configuration of the supply chain and planning the logistics operations in the development of new investments. To explore the viability of the proposed model, computational experiments are performed using the UK region of WM as a case study.

Keywords: *Waste to energy supply chains; Network design; Technology management; Fuzzy multi objective decision making*

References

- [1] Aviso, K.B., Tan, R.R., Culaba, A.B., Cruz Jr. J.B. (2011). Fuzzy input–output model for optimizing eco-industrial supply chains under water footprint constraints. *Journal of Cleaner Production*, 19, 187-196.
- [2] Li, Q., Hu, G. (2014). Supply chain design under uncertainty for advanced biofuel production based on bio-oil gasification. *Energy*, 74, 576–584.

A Methodology Based on Fuzzy ε -Constraint Method for Integrated Optimization of Sustainable Supply Chains and Transportation Networks for Multi Technology Bio-Based Production

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Abstract

Large capacity production systems require to develop a robust and integrated supply chain and logistics system where the bio-based resources and bio-products are shipped by different modes of transportation such as truck, rail and barge. As transport distance and mode plays a major role in energetic and environmental performance of the supply chain, the associated logistics network must be designed so as to ensure the best compromise between cost and environmental impact [1]. So that an economic advantage can be provided over non-renewable sourced systems and the issues related to sustainability can be defeated. To ensure sustainability in a bio-based supply chain, usually multiple conflicting objectives have to be considered. In addition, these systems are exposed to a number of system specific uncertainties such as resource/bioproduction prices, demand and resource yield. This study focuses on developing proper and effective optimization methodologies to select the most favorable supply chain configuration and design the transportation network to identify cost-efficient bio-based supply chain with a small environmental impact. The methodology integrates all supply chain activities from feedstock supply to product distribution and consumption, and all elements of the chain from biomass source sites to demand nodes. To this aim, a bi-level DSS is developed to optimize multi biomass based supply chains and transportation networks under co-modality considerations to produce multiple types of bioproducts by different technology options in the same supply chain. The first level identifies the optimum structure of the supply chain and selects the most appropriate production technologies under demand and feedstock availability limitations. In the second stage, based on the output from the first stage related to locations of nodes and the delivery amounts between the nodes, a model is developed to decide how optimally route the material flows from its origin to destination. The optimum and most sustainable mode and option of transportation is chosen along with the most appropriate stations to transfer the material between modes among available options under co-modality principles. To obtain optimized solutions, a hybrid algorithm is proposed combining fuzzy set theory and ε -constraint method in a novel way to capture both sustainability aspects by considering the trade-offs between different objectives and system specific uncertainties within the same framework. To explore the viability of the proposed DSS, computational experiments are performed on a case study of WM Region in the UK.

Keywords: *Supply chain design; transportation network design; bio-based production; fuzzy multi objective decision making*

References

- [1] Galvez, D., Rakotondranaivo, A., Morel, L., Camargo, M., Fick, M. (2015). Reverse logistics network design for a biogas plant: An approach based on MILP optimization and Analytical Hierarchical Process (AHP). *Journal of Manufacturing Systems*, 37, 616–623.

A Hybrid Approach Based on Fuzzy AHP and TOPSIS for Selection of Academic Conference

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Abstract

Academic conferences are the platforms where scientists are informed for the academic community the about their study by presenting their study [1]. There have being organized hundreds of international and national conferences around the world and in our country. It is not possible for an academics to attend all conferences. At this point, academics are trying to prefer reputable and competent conferences in the field. At the same time, in the selection process, various factors are taken into account such as the place of conference (country/city), conference registration fee, transport fee, etc. [2], [3]. In this study, it has been done among the six academical conferences to selection of the most appropriate conference for an academician in the department of industrial engineering. Analytic hierarchy process (AHP), which is a multicriteria decision making method due to be verbal of some opinions and include subjective evaluation, has been used with fuzzy number together. Opinion of five academician was taken as expert opinion. And the "Fuzzy AHP" method, expressed in terms of fuzzy numbers. Then, the most suitable conference selection was made by sorting the conference alternatives using the technique for order preference by similarity to ideal solution (TOPSIS) method.

Keywords: *Conference selection, Fuzzy AHP, TOPSIS*

References

- [1] Gür, S., Hamurcu, M., & Eren, T. (2016). Selection of academic conferences based on analytical network processes. *Multiple Criteria Decision Making*, 11, 51-62.
- [2] Yüncü, D. K., & Kozak, N. (2010). Türk akademisyenlerin kongre tercihleri üzerine bir araştırma. *Anatolia: Turizm Araştırmaları Dergisi*, 21(1). 109-120.
- [3] Chen C.F. (2006), Applying the analytical hierarchy process (AHP) approach to convention site selection, *Journal of Travel Research*, 45(2), 167-174.

An Extension of CODAS Method with Interval-Valued Intuitionistic Fuzzy Numbers

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Abstract

The study introduces an extension of CODAS (Combinative Distance-Based Assessment) method which is usable for group decision making in the uncertain environment. The extended method considers interval-valued intuitionistic fuzzy numbers to define the judgements of decision makers and use interval-valued intuitionistic fuzzy weighted aggregation (IIFWA) operator to aggregate the evaluations of decision makers. An explanatory numerical example is carried out and the preference ranking of the alternatives based on the presented method is obtained. To test the validity of the outputs of the proposed method, a comparison analysis is performed using IVIF-TOPSIS, IVIF-SAW and IVIF-VIKOR methods. Also, a sensitivity analysis is given considering randomly selected different IVIF weights of the criteria to see the variability of the preference rankings.

Keywords: Multi-criteria group decision making (MCGDM), Fuzzy environment, IIFWA operator

References

- [1] Keshavarz Ghorabae, M., Zavadskas, E. K., Turskis, Z., & Antucheviciene, J., (2016). A new combinative distance-based assessment (CODAS) method for multi-criteria decision-making. *Economic computation & economic cybernetics studies & research*, 50(3), 25-44.
- [2] Keshavarz Ghorabae, M., Amiri, M., Zavadskas, E. K., Hooshmand, R., & Antuchevičienė, J. (2017). Fuzzy extension of the CODAS method for multi-criteria market segment evaluation. *Journal of business economics and management*, 18(1), 1-19.
- [3] Xu, Z., (2007). Methods for aggregating interval-valued intuitionistic fuzzy information and their application to decision making [J]. *Control and Decision*, 2, 019.
- [4] Xu, Z. and Chen, J., (2007). An approach to group decision making based on interval-valued intuitionistic judgment matrices, *Systems Engineering – Theory and Practice*, 27 (4), 126–133.

A Fuzzy SLIM Based Quantitative Risk Analysis in Maritime Transportation Engineering

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Abstract

Risk analysis is of paramount importance for sustainable maritime transportation since shipping activities pose potential hazards to human life, environment and commodity. This paper prompts a quantitative risk analysis to systematically predict human error occurrence and severity of consequences. Hence, it can be ascertained the desired safety control level in maritime transportation activities. To achieve this purpose, Success Likelihood Index Methodology (SLIM), which is capable of quick evaluation human error probability (HEP), is used. In order to minimize subjectivity in the process of experts' elicitation, fuzzy sets are adopted to methodology. Whilst SLIM method is capable of predicting HEP, the fuzzy sets tackle with the vagueness of expert judgements during weighting process of performance influence factors. A quantitative risk analysis under fuzzy SLIM environment will be performed to very specific case on board ship: enclosed space entry. Practically, risk assessment must be carried out by a competent officer prior to entering an enclosed space such as ballast tanks, trunks, etc. where crew may suffer unconsciousness due to toxic gases or oxygen deficiency. In this paper, a quantitative risk analysis is performed to enhance safety control level and minimize potential hazards. The consequences of this paper will contribute safety inspectors and ship managers to predict risks in advance.

Keywords: *Fuzzy sets, SLIM, risk assessment, maritime transportation, decision-making.*

References

- [1] Embrey, D. E., Humphreys, P., Rosa, E. A., Kirwan, B., Rea, K. (1984). SLIM-MAUD: an approach to assessing human error probabilities using structured expert judgment. Volume II. Detailed analysis of the technical issues (No. NUREG/CR--3518-VOL. 2). Brookhaven National Lab..
- [2] Hollnagel, E. (1998). Cognitive reliability and error analysis method (CREAM). Elsevier.
- [3] Akyuz, E., Celik, M. (2015). Application of CREAM human reliability model to cargo loading process of LPG tankers. Journal of Loss Prevention in the Process Industries, 34, 39-48.
- [4] Akyuz, E., Celik, E. (2016). A modified human reliability analysis for cargo operation in single point mooring (SPM) off-shore units. Applied Ocean Research, 58, 11-20.

Use of Fuzzy MCDA for Assessment of Emergency Rallying Points

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Abstract

In disaster management, predetermined rallying points are a commonly used to keep victims of a natural disaster together so that a flow of information can be set up and aid can be provided effectively. This is important especially within 72 hours of occurrence. Schools, sports facilities, parks can be identified as rallying points. The appropriateness of such areas can be evaluated by criteria such as infrastructure facilities, accessibility, and size. Assessment of available points before a disaster occurs is important in order to complete any possible deficiencies and to make preliminary preparations to facilitate the operations. The number of rallying points in an area is also important since identification of a large number of points may have some negative effects during disaster such as unbalanced aid distribution, failure to provide sufficient manpower and fragmented flow of information. In this study, we aim to utilize fuzzy multiple criteria decision aiding tools to evaluate the available rallying points (currently, there are 60 points identified by Directorate of Disaster and Emergency) as well as to identify new potential points in Çankaya Region of Ankara, Turkey. For such a research, geographical information of the current and potential points are essential to measure the factors such as accessibility or size. We aim to utilize Geographic Information Systems (GIS) tools for data collection. Although we mention as rallying “points”, in reality they are “areas”. Therefore, the data on some criteria would expected to consist of intervals rather than exact points, which brings fuzziness in the assessment process. As a result of the study, we plan to determine rallying points, where the victims can receive effective services. We believe that such assessment is important in terms of effective management of the first 72 hours of operations and efficient use of limited human-equipment resources during disasters.

Keywords: *Multiple Criteria Decision Analysis; Fuzzy Data; Disaster Management; Geographic Information Systems*

References

- [1] Fırat Kılıcı, Bahar Yetiş Kara, Burçin Bozkaya. (2015). Locating temporary shelter areas after an earthquake: A case for Turkey. *European Journal of Operational Research*, 243(1), 323-332.
- [2] Jinghai Xu, Xiaozhe Yin, Dingchao Chen, Jiwen An, Gaozong Nie. (2016). Multi-criteria location model of earthquake evacuation shelters to aid in urban planning. *International Journal of Disaster Risk Reduction*, 20, 51-62.
- [3] Ashish Trivedi, Amol Singh. (2017). A hybrid multi-objective decision model for emergency shelter location-relocation projects using fuzzy analytic hierarchy process and goal programming approach. *International Journal of Project Management*, 35(5), 827-840.

Fuzzy Local Polynomial Regression Problem and Selection of Parameter

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Abstract

In this study, it is considered the fuzzy version of local polynomial regression problems. The nonparametric regression functions are fuzzy-number-valued functions. The Generalized Hukuhara differentiability of fuzzy functions is used for converting the problem to parametric shape. The appropriate least square problem is designed for minimizing of Diamond distance between two fuzzy sets. Different simulation studies have been made by developing fuzzy versions of traditional functions which are used in selection of smoothing parameters. Moreover, fuzzy local linear and fuzzy local cubic models are examined and compared.

Keywords: *Fuzzy local polynomial regression, Smoothing, Local linear models, Local cubic models, Bandwidth selections, GH differentiability, Fuzzy cross validation and generalized cross validation.*

References

- [1] Fan, J. and Gijbels, I. (1996) Local Polynomial Modeling and Its Applications. London, United Kingdom: Chapman&Hall/CRC.
- [2] Wang, N., Zhang, W. X., Mei, C. L. (2007). Fuzzy Nonparametric Regression Based on Local Linear Smoothing Technique. Intern. Journ. Information Sciences, 177, 3882-3900
- [3] Bede, B., Stefanini, L. (2013). Generalized Differentiability of Fuzzy-Valued Functions. Fuzzy sets and systems, 230, 119-141.
- [4] Yildiz, M. (2013). Analysis of Nonparametric Fuzzy Regression Models (Doctoral Dissertation, Anadolu University, Eskisehir, Turkey).

Two-Point Fuzzy Boundary Value Problems with Eigenvalue Parameter Contained in the Boundary Conditions

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Abstract

In this article, two- point fuzzy boundary value problem is defined under the approach generalized Hukuhara differentiability. This type of problem is associated with an operator in fuzzy Hilbert space. So several theorems are given for the eigenvalues of the problem.

Keywords: *Fuzzy eigenvalue, Fuzzy eigenfunction, Fuzzy Hilbert space, Generalized Hukuhara derivative*

References

- [1] Puri, L.M., Ralescu, D. (1983). Differentials of fuzzy functions. J. Math. Anal. Appl., V.91, pp.552-558.
- [2] Kaleva, O. (1987). Fuzzy differential equations. Fuzzy Sets and Systems, V.24, pp.301-317.
- [3] Goetschel, J., Voxman, W. (1986). Elementary fuzzy calculus. Fuzzy Sets and Systems, V.18, N.1, pp.31-43.
- [4] Akin, O., Khaniyev, T., Oruc, O., Turksen, I.B. (2014). Some possible fuzzy solutions for second order fuzzy initial value problems involving forcing terms. Applied And Computational Mathematics, V.13, N.2, pp.239-249.
- [5] Gultekin H., Altinisik N. (2017). On the eigenvalues and eigenfunctions of the Sturm-Liouville fuzzy boundary value problem. J. Math. Comput. Sci. V.7 , No. 4, 786-805.

A Weighted Approach for Ranking of Fuzzy Numbers

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Abstract

When fuzziness occurs, the ranking of fuzzy numbers is one of the important topics in several areas such as decision making, optimization, data analysis, artificial intelligence, forecasting (Asady, 2011, Kumar et al. 2011). Particularly, the selection of best choice from different alternatives in decision making problems can be based on the ranking of fuzzy numbers related with fuzzy data (Asady, 2011). In that case, an efficient ranking method can be facilitative to decision makers (Saeidifar, 2011). There are several approaches for ranking of fuzzy numbers in the literature. For example, Zhang et al. (2014) used a probability-based explanation, decision makers' probability judgment in the ranking of fuzzy numbers. Phuc et al. (2012) proposed two ranking functions based on the areas and the expectation of the centroid of fuzzy numbers. Considering "consistent ranking of fuzzy numbers and their images" property in the ranking, in this paper, a new weighted average ranking degree that allows the decision maker to give different weights to the left and right sides of the fuzzy numbers is proposed. The introduced weighted average ranking degree, \bar{Z}_{Ai} , combines 7 different ranking degrees, $Z_{Ai0}^L, Z_{Ai,\alpha}^L, Z_{Ai}^{K_1}, Z_{Ai}^{K_2}, Z_{Ai}^R, Z_{Ai0}^R, Z_{Ai,\alpha}^R, Z_{Ai}^{DM}$ which allow an efficient procedure on the ranking of fuzzy number with the same and symmetric spreads. The proposed weighted average ranking degree is applied to rank fuzzy numbers and the results are compared.

Keywords: Ranking, fuzzy numbers, uncertainty, fuzzy number's image.

References

- [1] Asady B. 2011. Revision of distance minimization method for ranking of fuzzy numbers. Applied Mathematical Modelling 35:1306–1313.
- [2] Kumar A, Singh P, Kaur A, Kaur P. 2011. A new approach for ranking nonnormal p-norm trapezoidal fuzzy numbers. Computers and Mathematics with Applications 61: 881–887.
- [3] Saeidifar A. 2011. Application of weighting functions to the ranking of fuzzy numbers. Computers and Mathematics with Applications 62: 2246–2258.
- [4] Phuc PNK, Yu VF, Chou SY, Dat LQ. 2012. Analyzing the ranking method for L–R fuzzy numbers based on deviation degree. Computers & Industrial Engineering 63: 1220–1226.
- [5] Zhang F, Ignatius J, Lim CP, Zhao Y. 2014. A new method for ranking fuzzy numbers and its application to group decision making. Applied Mathematical Modelling 38: 1563-1582.

Korovkin Type Approximation of Continuous Fuzzy-Number-Valued Functions via Power Series Methods of Summability

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Abstract

In this study we prove fuzzy Korovkin type approximation theorems for continuous fuzzy-number-valued functions via power series methods of summability and obtain related approximation results by using fuzzy modulus of continuity. Examples concerning approximation by fuzzy convolution type operators are also given to illustrate obtained results.

Keywords: Fuzzy positive linear operators, fuzzy Korovkin theory, power series methods

References

- [1] Anastassiou, G.A. (2004). Fuzzy approximation by fuzzy convolution type operators. *Comput. Math. Appl.*, 48, 1369–1386.
- [2] Anastassiou, G.A. (2005). On basic fuzzy Korovkin theory. *Stud. Univ. Babeş-Bolyai Math.*, 50, 3-10.
- [3] Anastassiou, G.A., Gal, S.G. (2006). On fuzzy trigonometric Korovkin theory. *Nonlinear Funct. Anal. Appl.*, 11, 385–395.
- [4] Anastassiou, G.A., Duman, O. (2008). Statistical fuzzy approximation by fuzzy positive linear operators. *Comput. Math. Appl.*, 55, 573-580.
- [5] Anastassiou, G.A., Demirci, K., Karakuş, S., (2011). A-summability and Fuzzy Korovkin-Type Approximation. *J. Fuzzy Math.*, 19(2), 443-452.
- [6] Demirci, K., Karakuş, S. (2013). Four-dimensional matrix transformation and A-statistical fuzzy Korovkin type approximation. *Demonstr. Math.*, 46(1), 37-49.
- [7] Talo, Ö., Bal, C., (2016). On statistical summability $(N; p)$ of sequences of fuzzy numbers. *Filomat*, 30(3), 873–884.
- [8] Sezer, S. A., Çanak, İ. (2017). Power series methods of summability for series of fuzzy numbers and related Tauberian Theorems. *Soft Comput.*, 21(4), 1057-1064.

Hermite-Hadamard Type Inequality for Strongly Preinvex Functions via Sugeno Integrals

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Abstract

Some inequalities have become an important cornerstone in mathematical analysis and optimization and many uses of these inequalities have been discovered in a variety of settings. Hermite-Hadamard inequality has been extended, refined and generalized in a number of ways, see for instance [1,3] and the references therein. In recent years, lot of efforts has been made by many mathematicians to generalize the classical convexity. A significant generalization of convex functions is that of invex functions introduced by Hanson [2]. Hanson's initial result inspired a great deal of subsequent work which has greatly expanded the role and applications of invexity in nonlinear optimization and other branches of pure and applied sciences. Weir and Mond [9] and Noor [4,5] have studied the basic properties of the preinvex functions and their role in optimization, variational inequalities and equilibrium problems. Moreover, the Hermite-Hadamard inequalities are being obtained for the convex functions and its variant forms [6,7,8]. Motivated and inspired by the activities, we obtain the Hermite-Hadamard type inequality for Sugeno integrals based on strongly preinvex functions. Some examples are given to illustrate the results.

Keywords: *Hermite-Hadamard Inequality, Strongly Preinvex Function, Sugeno Integral*

References

- [1] Caballero, J., Sadarangani, K. (2009) Hermite-Hadamard inequality for fuzzy integrals, Appl. Math. Comput. 215, 2134-2138.
- [2] Hanson, M. A. (1981) On sufficiency of the Kuhn-Tucker conditions, J. Math. Anal. Appl. 80, 545-550.
- [3] Li, D-O., Song, X-Q., Yue, T. (2014) Hermite-Hadamard type inequality for Sugeno integrals, Appl. Math. Computation. 237, 632-638.
- [4] Noor, M. A. (1994) Variational-like inequalities, Optimization, 30(1994), 323-330.
- [5] Noor, M. A. (2005) Invex equilibrium problems, J. Math. Anal. Appl., 302, 463-475.
- [6] Noor, M. A. and Noor K. I. (2006) Some characterizations of strongly preinvex functions, J. Math. Anal. Appl. 316, 697-706.
- [7] Sugeno, M. (1974) Theory of fuzzy integrals and its applications (Ph.D. thesis), Tokyo Institute of Technology.
- [8] Turhan, S., Okur Bekar, N., Maden, S. (2015) Hermite Hadamard Type Inequality for Preinvex Functions via Sugeno Integrals, Fuzzyss' 15, p.n: 2825378.
- [9] Weir, T. and Mond, B. (1988) Preinvex functions in multiobjective optimization, J. Math. Anal. Appl. 136, 29-38.

Evaluation of Development Regions in Turkey in Terms of IPA Supports Using Fuzzy PROMETHEE and Fuzzy MULTIMOORA

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Abstract

European Union is a project focused on the balanced distribution of the prosperity, established by the common market, to all regions. For this purpose, in order to collect comparable statistics, socio-economic zones have been established within the framework of certain criteria using the classification of Nomenclature of Territorial Units for Statistics (NUTS). These regions are formed in 3 levels, based on the countries that are members and candidates for membership. Supports provided within the framework of the EU in order to reduce regional socio-economic disparities and to ensure regional development are being made and measured on the basis of regions (development zones) established with Level 2 NUTS. As a candidate country to the EU, Turkey also tries to achieve harmonization and regional development through Instrument for Pre-Accession Assistance (IPA). In this study, the extent to which the development regions identified in the Turkish scale should benefit from such supports is assessed on the basis of specific criteria. How to distribute IPA support, which is a limited resource, to the regions according to framework agreements and regional development goals is a complex issue. In order to solve this problem, development zones are evaluated using two different Multi Criteria Decision Making methods. The results obtained using Fuzzy-PROMETHEE and Fuzzy-MULTIMOORA are compared with each other to evaluate the effectiveness of different methods. As a result, a framework to provide specific distribution of funds to support regional development and to show the weaknesses of these regions is presented.

Keywords: *IPA Support, NUTS, Fuzzy PROMETHEE, Fuzzy MULTIMOORA, Evaluation.*

References

- [1] Özbek, O.. (2012). Normative regions and provincial development planning in Turkey. Journal of Amme İdaresi vol.45, p.129-154.
- [2] Afful-Dadzie, E., Nabareseh, S., Oplatková, Z.K., Klimek, P.. (2016). Using fuzzy PROMETHEE to select countries for developmental Aid. Intelligent Systems and Applications. Springer International Publishing, p.109-132.
- [3] Reeves, T.. (2006). Regional Development in the EU and Turkey. 1. Bölgesel Kalkınma ve Yönetişim Sempozyumu, Ankara, p.29-38.

Fuzzy Integral and Cuckoo Search Based Combined Classifier for Human Action Recognition

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Abstract

Recognition of human actions is an important issue. Real time action recognition and video surveillance are widely available in areas such as sports analysis and health monitoring. The most important issue in action recognition can be expressed as time. Because it is very important to determine the movement and to determine it quickly. Early detection of human actions can be used to monitor criminal activities, detect patient falls, and identify actions in rehabilitation centers. Especially the determination of the fall of old people as early as possible is very important for rapid intervention. With the development of mobile phones, accelerometer sensors embedded in these phones have been used to detect human actions. In this study, a new method for recognizing human actions by using signals received from accelerometer sensors of a mobile phone is proposed. The proposed method combines the fuzzy integral and cuckoo search algorithm. The proposed method acquires signals from three acceleration sensors and extracts some features by applying signal processing methods. In the classification stage, decision tree, support vector machines and linear discriminant analysis are used. The fuzzy integral is used to aggregate the outputs of these classifiers. The optimal confidence levels of the classifiers are adjusted by using the cuckoo search algorithm. The results show that the proposed method gives better results than the individual classifiers. Also, setting the classifiers' confidence levels has increased the classification performance of combined classifier.

Keywords: *Action Recognition, Feature Extraction, Fuzzy Integral, Cuckoo Search, Classification.*

References

- [1] M. Vrigkas, V. Karavasilis, C. Nikou, I. A. Kakadiaris (2014). Matching mixtures of curves for human action recognition, *Computer Vision and Image Understanding*, Vol. 119, pp. 27–40.
- [2] L. Mendez, J. R. Casas (2012). Model-based recognition of human actions by trajectory matching in phase spaces, *Image and Vision Computing*, 30, pp. 808–816.
- [3] L. Bao, S. Intille (2004). Activity recognition from user-annotated acceleration data. In *Pervasive computing, Lecture notes in computer science*, Vol. 3001, pp. 1–17. Springer
- [4] L. Chen, J. Hoey, C. Nugent, D. Cook, Z. Yu (2012). Sensor-based activity recognition. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews*, Vol. 42, pp. 790–808.
- [5] J. R. Kwapisz, G.M. Weiss, S.A. Moore (2011). Activity recognition using cell phone accelerometers *SIGKDD, Explor. Newsl.* 12, pp. 74–82
- [6] C. Catal, S. Tufekci, E. Pirmit, G. Kocabag (2015). On the use of ensemble of classifiers for accelerometer-based activity recognition, *Applied Soft Computing*, Vol. 37, pp. 1018–1022.

An Economy Class Service Systems Analysis Based on Fuzzy Methodologies

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Abstract

In the new world environment, airline service industry has a big potential owing to the unending demand in the market. As a result, entrepreneurs prefer to run in this market for the higher possibility of rapid grow and rising profit margin, but besides its glamour, it is difficult to compete in such a market where there is a high diversity of companies running their businesses with full daintiness, discretion and professionalism. Quality function deployment (QFD) method was originated in the late 1960s to early 1970s, in Japan [1]. It is an overall concept that provides translating customer needs into the appropriate design requirements for each stage of product development, production and lately service industry as well. Various applications and studies have shown many benefits and drawbacks of QFD, and that situation prompted the need for new approaches for the application of the QFD method, since the fuzzy QFD is developed to solve the uncertainty and imprecision. The original PROMETHEE method is a MCDM technique developed by Brans [2] and it is well adopted to problems where a finite number of alternative actions had to be ranked considering several, sometimes conflicting, criteria [3]. Fuzzy PROMETHEE helps the decision maker to handle the uncertain nature of the structure of decision process, which arises from the fuzziness and uncertainty of the reviews and expressions related to problem data. In this paper, the fuzzy QFD and fuzzy PROMETHEE methods are used to obtain certainty in the final results and eliminate the effect of vagueness coming from the linguistic input data, as an evaluation tool for economy class service systems analyses for airline transportation companies. By this means, the voice of the customer is collected and analyzed through the employment of fuzzy QFD methodology according to be able to increase the customer satisfaction, where linguistic data used in the assessments is handled by fuzzy set theory which is employed to treat these data as quantitative amounts and, so to have a closer exactness in the representation of it. To show the effectuality and accuracy of the proposed combined approach, a real world application is also executed at the end of the paper.

Keywords: *Fuzzy QFD, Fuzzy PROMETHEE, Service systems analyses, Airline market*

References

- [1] Akao, Y. (1990). Quality function deployment: Integrating customer requirements into product design. Portland: Productivity Press.
- [2] Brans, J. P. (1982). L'ingénierie de la décision; Elaboration d'instruments d'aide à la décision. La méthode PROMETHEE". L'aide à la décision: Nature, Instruments et Perspectives d'Avenir, 183–213.
- [3] Goumas, M., & Lygerou, V. (2000). An extension of the PROMETHEE method for decision making in fuzzy environment: Ranking of alternative energy exploitation projects. European Journal of Operational Research, 123, 606-613.

Fuzzy Clustering Analysis in Gene Expression Data

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Abstract

Clustering is the process of grouping the data into clusters, so that objects within a cluster have as possible as similarity in comparison to one another, but are very different to objects in other clusters. Cluster analysis is used for identifying biologically relevant groups of genes under various conditions. The biological activities of a gene are more complex. But conventional clustering algorithms allow objects to be assigned to a single cluster. These methods do not enable information about the influence of a given gene for the overall shape of clusters. To overcome this harsh condition, fuzzy clustering algorithms, which are more flexible techniques, can be used. In contrast to classical clustering algorithms, fuzzy clustering algorithms allow each gene to be bound to all clusters via a real valued vector. In this work we apply a fuzzy partitioning method, Fuzzy C- Means (FCM) algorithms on microarray time courses data. The results were simply analyzed.

Keywords: Cluster Analysis, Fuzzy Clustering, Fuzzy C-Means Algorithm, Microarray data.

References

- [1] Bezdek, J.C. (1981). Pattern Recognition with Fuzzy Objective Function Algorithms. Plenum Press, New York.
- [2] Eisen, M. B., Spelman, P.T, Brown, P.O. and Botstein, D. (1998). Cluster analysis and display of genome- wide expression patterns. Proc. Natl Acad. Sci. USA, 95, 14863-14868.
- [3] Hoppner F., Klawonn F., Kruse R., and Runkler T. Fuzzy Cluster Analysis. JohnWiley and Sons, 1999.

LabVIEW Based Fuzzy Identifier for Power Quality Disturbances

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Abstract

The enormous increase in the amount of electronic equipment lead to increase power consumption. Increased power consumption has led to some power quality (PQ) problems. PQ disturbances include voltage sag, voltage swell, flicker, waveform distortion, interruption, transient, etc. If the type of disturbance can be determined correctly, the reasons for them can be understood. This has attracted the attention of researchers on PQ disturbances. Most of the investigations have attempted to identify problems using signal processing applications. Signal processing applications often consist of three stages that are preprocessing, feature extraction and classification. Most of the fuzzy applications and signal processing applications have been done with MATLAB, but in this paper PQ disturbances have been investigated through LabVIEW that is a graphics-based software platform. The use of LabVIEW has been increasing in engineering applications and in the signal processing field. It provides a visual platform for development of algorithms. For identify disturbances fuzzy system has used. Extracted parameter has been given to fuzzy system. There are two inputs and two output. The first input is the amplitude of the voltage waveform and the second input is the frequency of the voltage waveform. The first input has three membership functions that are Low (L), Normal (N) and High (H). The second input has three membership functions that are Low Frequency (LF), Normal Frequency (NF), and High Frequency (HF). First output has four membership functions. There are Normal, Sag, Swell, and Interruption. The second output has two membership functions. There are Normal and Distorted Frequency (DF). Different combination of signals were created through the software. The simulation results indicate that created interfaces have ability to identify PQ disturbances successfully.

Keywords: *LabVIEW, Fuzzy Logic, Power Quality*

References

- [1] Abdelsalam, A. A., Eldesouky, A. A., and Sallam, A. A. (2012). Characterization of power quality disturbances using hybrid technique of linear Kalman filter and fuzzy-expert system. *Electric power systems Research*, 83(1), 41-50.
- [2] Montoya, F. G., García-Cruz, A., Montoya, M. G., and Manzano-Agugliaro, F. (2016). Power quality techniques research worldwide: A review. *Renewable and Sustainable Energy Reviews*, 54, 846-856.
- [3] Sundaram, P. K., and Neela, R. (2016). Hilbert Transform based Fuzzy Expert System for Diagnosing and Classifying Power Quality Disturbances. *International Journal of Computer Applications*, 142(3).

Simulation Based Multi-Criteria Analysis of the Factors Used for the Evaluation of Retail Location Selection

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Abstract

One of the most important strategies in retailing is to expand market and reach more customers to maintain presence in such a competitive environment. Location of retail store provides competitive and unique advantage to retailers. Selection of location is an important strategic decision which has great effect on overall success of the retailer since such decisions involve long-term commitment of resources and generally represent a substantial investment which may affect the long-term profitability and sustainability [1], [2]. It can be said that location is the most important among all factors affecting the success of the retailers [3]. Retail location selection decision is a critical and complex process which requires the evaluation and aggregation of multiple criteria and also the usage of appropriate data related to them. One of the important points is the determination of the importance level of the factors used in retail location selection. This study aims to present a Monte Carlo simulation based multi-criteria decision making (MCDM) approach for determining the importance of the criteria used in the retail location selection. The presented approach integrates Monte Carlo simulation and hesitant fuzzy linguistic term sets (HFLTS) [4] based analytic hierarchy process (AHP) methods to represent the uncertainty and ambiguity of the evaluation process based on subjective judgements. The presented approach also enables the selection among retail location alternatives and can be used in strategic planning process of retail firms. A real life application of the proposed approach is also presented.

Keywords: Retail Location, Fuzzy Sets, Monte Carlo Simulation, Multi-Criteria Decision Making

References

- [1] Tolga, A. C., Tuysuz, F., & Kahraman, C. (2013). A fuzzy multi-criteria decision analysis approach for retail location selection. *International Journal of Information Technology & Decision Making*, 12(04), 729-755.
- [2] Erbiyik, H., Özcan, S., & Karaboğa, K. (2012). Retail store location selection problem with multiple analytical hierarchy process of decision making an application in Turkey. *Procedia-Social and Behavioral Sciences*, 58, 1405-1414.
- [3] Levy, M., & Weitz, B. A. (2009). *Retailing Management*, New York: The McGraw-Hills/Irwin.
- [4] Rodríguez, R. M., Martínez, L., & Herrera, F. (2012). Hesitant fuzzy linguistic term sets for decision making. *Fuzzy Systems, IEEE Transactions on*, 20(1), 109-119.

Academic Journal Selection for Academicians by Using Fuzzy Multicriteria Decision Making Methods

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Abstract

The most important subject to be addressed after the writing process of academicians is the selection of the journal where the academic article will be sent for publication [1]. The fact that an academic study done can only be published in a journal reveals the importance of journal selection. The main points to be taken into consideration in the selection of the journal are the aim and scope of the journal, the indices to which the journal is scanned, the impact factor and the publication frequency [2], [3]. It is necessary to used multicriteria decision making techniques due to the large variety in the journals and the various of evaluation criteria. In this study, the most appropriate ranking of journal selection was done for academics in the industrial engineering department by using fuzzy analytic hierarchy process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods.

Keywords: *Academic Journal selection, Fuzzy analytic hierarchy process, TOPSIS, Multicriteria decision making, fuzzy sets*

References

- [1] Sipahi, O. R. (2011). Makale yayınlama sürecinde dergi seçimi. ANKEM Dergisi, 25(2), 229-232.
- [2] Knight, L.V. and Steinbach T.A. (2008). Selecting an appropriate publication outlet: a comprehensive model of journal selection criteria for researchers in a broad range of academic disciplines. International Journal of Doctoral Studies. 3: 59-79.
- [3] Shokraneh, F., Ilghami, R., Masoomi, R., & Amanollahi, A. (2012). How to select a journal to submit and publish your biomedical paper?, BioImpacts: BI, 2(1), 61.

Robot Selection in a Computer Integrated Manufacturing Cell with Fuzzy Multi-Criteria Decision Making

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Abstract

In Computer Integrated Manufacturing (CIM), there are hardware and software components of the system. Components of hardware part include computers, Computer Numerical Control (CNC) machines, automatic carrying sub-systems (such as conveyor and automatic storage systems) and robots. Robots are critical in the system because nearly all loading and retrieval tasks are conducted by them. Therefore, for creating a CIM system with high sustainability and flexibility, suitable robots must be selected for related machines. The variety of robots with different capabilities makes it harder to select the most suitable ones for a system. In this study, firstly, robots in a CIM system are classified according to technical characteristics and capabilities. Secondly, a robot selection model is developed with fuzzy Analytic Hierarchy Process (AHP). Technical and financial criteria are used in the model. Thirdly, an application is carried out in CIM cell of Kırıkkale University Industrial Engineering Department. Finally, an ideal design with the best alternative robots is created by using fuzzy AHP for the system.

Keywords: *Robot Selection, Computer Integrated Manufacturing (CIM), Fuzzy Analytic Hierarchy Process (AHP)*

References

- [1] Liang G. S., Wang M. J. J. (1993). A fuzzy multi-criteria decision-making approach for robot selection. *Robotics and Computer-Integrated Manufacturing*, 10 (4), 267-274.
- [2] Kahraman C., Çevik S., Ateş N. Y., Gülbay M. (2007). Fuzzy multi-criteria evaluation of industrial robotic systems. *Computers and Industrial Engineering*, 52 (4), 414-433.
- [3] Soota T. (2014). Integrated Approach to Multi-Criteria Decision Making for Sustainable Product Development. *International Journal for Quality Research*, 8 (4), 543-556.

A Cooperative Mission Planning of UAV Swarms Based on Fuzzy Decision Making

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Abstract

Coordination of unmanned aerial vehicles (UAV) is becoming more important as day by day use increases in each area. Coordination between UAVs is extremely critical, especially in the case of multiple target tracking with multiple UAVs. From this point of view, research and studies for the task planning of herd UAVs and herd UAVs are also increasing. There are various algorithms in the literature in which optimization algorithms are used for task scheduling of UAVs, but studies that reflect the expertise in decision making process have not been done yet. In this study, an approach that uses fuzzy decision making for collaborative task planning of multiple UAVs is proposed. The necessary algorithms are given in the study to decide whether the subdivided UAVs divided in terms of duty within the herd decide the total herd in the course of the UAV's mission planning, or each UAV should act in accordance with and coordinated with the UAV. To verify the proposed approach, simulations were performed on the computer and comparative results were obtained. Especially, it is seen that the use of only optimization algorithms for collaborative task planning of a lot of UAVs is insufficient in many cases and a decision making algorithm must be used for effective performance. The contribution made by using the blurred decision making approach in the task planning of a large number of UAVs, which become a complex system when considering the factors such as friend, enemy, obstacle and target within the scope of task planning, are clearly revealed with the results. Considering that a large number of realistic scenarios can be created in an environment where these factors are present, the importance of improving the methods to be used for cooperative task scheduling of large UAVs is better understood. Within the scope of this study, simulation studies involving the proposed method are evaluated comparatively by considering all aspects of the problem.

Keywords: *Swarm UAVs, Fuzzy decision making, Mission planning.*

References

- [1] Fabio Morbidi, Randy A. Freeman, Kevin M. Lynch, (2011), Estimation and control of UAV swarms for distributed monitoring tasks, Proceedings of the 2011 American Control Conference, 1069-1075.
- [2] Carlos Sampedro, Hriday Bavle, Jose Luis Sanchez-Lopez, Ramon A. Suárez Fernández, Alejandro Rodríguez-Ramos, Martin Molina, Pascual Campoy, (2016), A flexible and dynamic mission planning architecture for UAV swarm coordination, 2016 International Conference on Unmanned Aircraft Systems (ICUAS), 355-363.
- [3] Kuo-Chen Hung, Kuo-Ping Lin, Michael Yin, (2009), Enhancement of Fuzzy Weighted Average and Application to Military UAV Selected under Group Decision Making, Sixth International Conference on Fuzzy Systems and Knowledge Discovery, 191-195.

Fuzzy Logic Based Control of a Fluid Conveying Cantilever Pipe

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Abstract

The purpose of this paper is to investigate the dynamic behavior of a fluid conveying pipe and to propose suitable control strategies in order to eliminate or suppress its vibration. The system under consideration consists of a uniform, straight, vertical cantilever pipe which conveys incompressible fluid. Governing equation of motion for free transverse vibration is derived by using Newtonian approach. This equation is discretized using the finite element method. The natural frequencies of the system are then determined for the cases where the pipe conveys fluid with zero and nonzero velocities. The effects of the fluid flow speed on open loop response of the system are investigated. The results show unstable behavior when the flow velocity exceeds a critical value. A PI controller and a fuzzy logic based controller are applied to the system to suppress the pipe vibration and to improve the stability conditions. The results show that fuzzy logic based controller behaves like a PI controller at low flow velocities and successfully suppresses the vibration. Moreover, it holds the system response in the stable region at higher flow velocities.

Keywords: *fluid conveying, cantilever pipe, fuzzy control, dynamic analysis*

References

- [1] Paidoussis, M. P. (1998) Fluid-Structure Interactions: Slender Structures and Axial Flow, Volume 1. London, United Kingdom: Academic Press.
- [2] Paidoussis, M. P. and Issid, N. T. (1974). Dynamic stability of pipes conveying fluid. *Journal of Sound and Vibration*, 33(3), 267-294
- [3] Yigit, F., (2008). Active Control of Flow-Induced Vibrations via Feedback Decoupling. *Journal of Vibration Control*, 14 (4), 591–608.
- [4] Demir, M. H. (2012). Akişkan taşıyan ankastre bir borunun dinamik analizi ve bulanık mantık tabanlı uyarlamalı kontrolü (Master's thesis, Istanbul Technical University, Istanbul, Turkey).

Evaluation of Monorail Route Alternatives by Using a Fuzzy Analytic Hierarchy Process

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Abstract

Multicriteria decision making methods are frequently used in decision making processes for urban transportation planning. It has a wide use such as transportation network planning, vehicle selection, location selection, station location selection, project selection. One of these decision processes is the route planning decisions [1], [2]. This study is about the route selection for monorail which is considered for Ankara. It has been tried to be selected the most suitable route among the alternative routes for monorail. Analytic hierarchy process (AHP) is used with fuzzy sets together that is one of the multicriteria decision making methods in the selection process [3]. Fuzzy sets make it easy to incorporate intangible expressions into the decision process. As a result, the most suitable route was determined for the monorail that will able to improve urban transport.

Keywords: *Monorail, Urban transport, Monorail route alternatives, Fuzzy Analytic Hierarchy Process*

References

- [1] Gür, Ş., Hamurcu, M. and Eren, T. (2017). Ankara'da Monoray projelerinin analitik hiyerarşi prosesi ve 0-1 hedef programlama yöntemleri ile seçimi. Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi 23 (4), 437-443.
- [2] Hamurcu, M., Gür, Ş., Özder, E. H., and Eren, T. (2016). A multicriteria decision making for monorail projects with analytic network process and 0-1 goal programming. International Journal of Advances in Electronics and Computer Science (IJAECs), 3(7), 8-12.
- [3] Enea, M., and Piazza, T. (2004). Project selection by constrained fuzzy AHP. Fuzzy optimization and decision making, 3(1), 39-62.

A Review and Classification of Approaches for Dealing with TODIM and Its Applications

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Abstract

Multi criteria decision making (MCDM) is one of the most widely studied research areas of operations research by researchers and practitioners. Several methods have been proposed for this area and the vast majority of these methods have been integrated with fuzzy logic and its various versions. The TODIM method (an acronym in Portuguese of interactive and multi-criteria decision making) is one of these MCDM methods based on prospect theory, which can capture the decision maker's bounded rationality in the process of making an actual decision. The main novelty of this method is regarding the dominance degree of each alternative against the others by using the utility function originating from the prospect theory. It continues to be applied satisfactorily across different application areas using fuzzy sets and its extensions such as interval type-2 fuzzy sets, hesitant fuzzy sets, intuitionistic fuzzy sets and Pythagorean fuzzy sets. Therefore, in this study, it is conducted a literature review and classification to analyze and interpret the current research on TODIM applications. Papers are classified into different application areas and a number of sub-application areas. Furthermore, all papers are also categorized with respect to publication year, published journal, country of origin, application type (real case study vs. empirical study), and version of fuzzy sets used. This study provides an insight for researchers and practitioners on TODIM applications in terms of showing current state and potential areas for future attempts to be focused in the future.

Keywords: *TODIM, multi criteria decision making, fuzzy sets, review, classification*

References

- [1] Gomes, L. F. A. M., & Lima, M. M. P. P. (1992). TODIM: Basics and application to multicriteria ranking of projects with environmental impacts. *Foundations of Computing and Decision Sciences*, 16(4), 113-127.
- [2] Celik, E., Gul, M., Aydin, N., Gumus, A. T., & Guneri, A. F. (2015). A comprehensive review of multi criteria decision making approaches based on interval type-2 fuzzy sets. *Knowledge-Based Systems*, 85, 329-341.
- [3] Gul, M., Celik, E., Aydin, N., Gumus, A. T., & Guneri, A. F. (2016). A state of the art literature review of VIKOR and its fuzzy extensions on applications. *Applied Soft Computing*, 46, 60-89.

An Application of Multi-Criteria Decision-Making Approach on Selection of a Honeycomb Heat Sink

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Abstract

In the present study, a Visekriterijumska Optimizacija I Kompromisno Resenje (VIKOR) based multi-criteria decision-making (MCDM) approach is applied to a selection problem of a heat sink, which is used to control the temperature of electronic devices at around an acceptable level and thus to enhance the reliability and life of electronic devices. This study is a logical extension of the study of Subaşı et al. [1] in which a Pareto-based multi objective optimization is conducted to determine the optimum values of the design parameters of a honeycomb heat sink. The aim of this study is to compare the Pareto optimal solutions determined in [1] and to help the decision maker to select the best design among these Pareto optimal solutions in the decision stage. In the study, the VIKOR method is used to evaluate the alternatives of the Pareto optimal solutions regarding two criteria as being the Nusselt number (Nu) and the friction factor (f). The various weights are determined for Nu and f, and fifteen alternatives are presented for each case. The results presented here are expected to help the decision maker to choose the best solution during the design and development of the honeycomb heat sink.

Keywords: *Honeycomb, Heat sink, Multi-objective optimization, Pareto optimal solutions, Multi-criteria decision-making, VIKOR*

References

- [1] Subaşı, A., Şahin, B., Kaymaz, İ., 2016, Multi-objective optimization of a honeycomb heat sink using Response Surface Method, International Journal of Heat and Mass Transfer, 101, 295-302.

A Comparison Study of F-AHP Based MCDM Methods on Green Concept Selection Problem

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Abstract

The demand of green products has dramatically increased because the importance and public awareness of the preservation of natural environment was taken into consideration much more last two decades. As a result of this, especially manufacturing companies have been forced to design more green products, resulting in a problem of how they incorporate environmental issues into their design and evaluate concept options. The need for the practical decision making tools to address this problem is rapidly evolving due to the fact that the problem turns into a multiple-criteria decision making (MCDM) problem in the presence of a set of green concept alternatives and criteria. Therefore; in this paper, the three popular MCDM methods in fuzzy environment are utilized to reflect the vagueness and uncertainty on the judgments of DMs, because the crisp pairwise comparison in these conventional MCDM methods seems to be insufficient and imprecise to capture the right judgments of DMs. Of these methods; as F-AHP is used to calculate criteria weights, the other methods; F-TOPSIS, and F-GRA are used to rank alternatives in the two different ways for a comparative study. Furthermore, the incorporation of fuzzy set theory into these methods is discussed on a real-life case study, and a comparative analysis is done by using its numerical results in which the two fuzzy-based methods reveal the same outcomes (or rankings), while F-GRA requires less computational steps.

Keywords: *New product development, green concept selection, multiple-criteria decision making, fuzzy logic, AHP, TOPSIS, GRA*

References

- [1] Saaty, T. L. (1981). The Analytical Hierarchy Process. New York: McGraw Hill.
- [2] Samanlioglu, F., Ayağ, Z. (2016). A fuzzy ANP-based PROMETHEE II approach for evaluation of machine tool alternatives. *Journal of Intelligent and Fuzzy Systems*, 30, 2223-2235.
- [3] Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, 8, 338-353.
- [4] Ayag, Z. (2005a). An integrated approach to evaluating conceptual design alternatives in a new product development environment. *International Journal of Production Research*, 43(4), 687-713.
- [5] Ayag, Z. (2005b). A fuzzy AHP-based simulation approach to concept evaluation in a NPD environment. *IIE Transactions*, 37, 827-842.
- [6] Lakshmi, T.M. and Venkatesan, V.P. (2014). A Comparison of various normalization in techniques for order performance by similarity to ideal solution (TOPSIS), *International Journal of Computing Algorithm*, 3, 882-888.

Intuitionistic Fuzzy Topological Transformation Groups

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Abstract

In this talk, we extend the notion of fuzzy topological transformation group to intuitionistic fuzzy topological transformation group. We investigate orbits and invariant subsets in intuitionistic structure. Finally, we construct some new intuitionistic fuzzy topological transformation groups.

Keywords: *Intuitionistic fuzzy topological space, Intuitionistic fuzzy topological group, transformation group.*

References

- [1] Atanassov, K., (1986) Intuitionistic fuzzy sets, Fuzzy Sets and Systems 20, 87-96.
- [2] Coker, D., (1997) An introduction to intuitionistic fuzzy topological space, Fuzzy Sets and Systems 88, 81-89.
- [3] Foster, D. H. (1979) Fuzzy Topological Groups, J. Math. Anal. Appl. 67, 549-556.
- [4] Hur, K., Kang, H. W. and Song, H. K. (2003) Intuitionistic fuzzy subgroups and subrings, Honam Math.J. 25, 19-41.
- [5] Hur, K., Kim, J. H. and Ryou, J. H. (2004) Intuitionistic fuzzy topological spaces, J. Korea Soc. Math. Edu. Ser. B: Pure Appl. Math. 11, 243-265.
- [6] Hur, K., Jun, Y. B. and Ryou, J. H. (2004) Intuitionistic fuzzy topological groups, Honam Math. J. 26, 163-192.
- [7] Atanassov, K. (1984) Intuitionistic fuzzy sets, in: V. Sgurev, Ed., VIIIITKR's Session, Sofia (June 1983 Central Sci. and Techn. Library, Bulg. Academy of Sciences).
- [8] Zadeh, L. A. (1965) Fuzzy sets, Inform. Control 8,338-353.
- [9] Lowen, R. (1976) Fuzzy topological spaces and Fuzzy compactness, J. Math. Anal. Appl. 56, 621-633.
- [10] Ali, T., Das, S. (2009). Fuzzy Topological Transformation Groups, Journal of Mathematics Research, vol 1, no 1.
- [11] Gottschalk, W.H. and Hedlund, G.A. (1955), Topological Dynamics, AMS.

Initial Value Problems in Intuitionistic Fuzzy Environment

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Abstract

The fuzzy set theory was firstly introduced by L. Zadeh in 1965 [1]. For many reasons, it is known that vagueness or uncertainty is inevitable in science and engineering. To get more realistic mathematical models for such situations he introduced a new set concept having elements with a function $\mu(x): X \rightarrow [0, 1]$, called membership function. However, since the membership function may have uncertainty in some applications owing to the subjectivity of the expert or the imprecision in the nature of models, it was seen that fuzzy set theory does not give information for this hesitation degree. To generalize fuzzy set theory, some extensions were introduced. One of these extensions is Atanassov's intuitionistic fuzzy set (IFS) theory [2]. In 1986, Atanassov [2] introduced the concept of intuitionistic fuzzy set and carried out rigorous researches to develop its theory. In this theory, he introduced a new degree $\nu(x): X \rightarrow [0, 1]$, called non-membership function, to a classical fuzzy set such that the sum $\mu + \nu$ is less than or equal to 1. Further the difference $1 - (\mu + \nu)$ is regarded as degree of hesitation. Hence, since intuitionistic fuzzy set theory contains membership function, non-membership function and the degree of hesitation it can be regarded as a tool which is more flexible and more human consistent reasoning in handling uncertainty due to imprecise knowledge or data. Intuitionistic fuzzy set and fuzzy set theory has flourishing interesting applications in different fields of science and engineering such as decision-making problems, image processing and pattern recognition, medicine, fault analysis. Szmidt et. al [3] showed that intuitionistic fuzzy sets are pretty useful and demonstrated some applications of intuitionistic fuzzy sets in some cases where description of a linguistic variable problem was given in terms of a membership function. The main idea of this paper is to study the fundamental properties of initial value problems in intuitionistic fuzzy environment. To do this, we have extended the fundamental properties fuzzy initial value problems to intuitionistic fuzzy environment by using generalized Hukuhara differentiability concept. Then, we have given some numerical applications.

Keywords: *Intuitionistic fuzzy sets, initial value problems, generalized Hukuhara differentiability*

References

- [1] L. A. Zadeh, Fuzzy sets, Information and Control, (1965).
- [2] T. Atanassov, K. T. Atanassov, Intuitionistic fuzzy sets, Fuzzy Sets Syst. 20 (1986) 87–96.
- [3] E. Szmidt, J. Kacprzyk, Intuitionistic fuzzy sets in some medical applications, Note on IFS 7 (4) (2001) 58–64.

Intuitionistic Fuzzy 2-Absorbing Primary Ideals of Commutative Rings

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Abstract

Aim of this study is to give a definition of intuitionistic fuzzy 2-absorbing primary ideals and intuitionistic fuzzy weakly completely 2-absorbing primary ideals of commutative rings besides give their properties. Moreover, images and inverse images of these ideals are studied. Finally, we give a diagram which transition between definitions of intuitionistic fuzzy 2-absorbing primary ideals of commutative rings.

Keywords: *Fuzzy Set, Intuitionistic Fuzzy Set, Intuitionistic Fuzzy Prime Ideal, Intuitionistic Fuzzy Weakly Completely Prime Ideal, 2-absorbing ideal, Intuitionistic Fuzzy 2-Absorbing Primary Ideal, Intuitionistic Fuzzy Weakly Completely 2-Absorbing Primary Ideal.*

References

- [1] Zadeh, L. A. (1965), Fuzzy Sets, Inform. and Control, 8(3), 338-353.
- [2] Badawi, A. (2007), On 2-Absorbing Ideals of Commutative Rings, Bull. Austral. Math. Soc., 75(3), 417-429.
- [3] Badawi, A., Tekir, U., Yetkin, E. (2014), On 2-Absorbing Primary Ideals in Commutative Rings, Bull. Austral. Math. Soc., 51(4), 1163-1173.
- [4] Callıalp, F., Yetkin, E., Tekir, U. (2015), On 2-Absorbing Primary and Weakly 2-Absorbing Primary Elements in Multiplicative Lattices, Italian Journal of Pure and Applied Math., 34, 263-276.
- [5] Mukherjee, T. K., Sen, M. K. (1993), Primary Fuzzy Ideals and Radical of Fuzzy Ideals, Fuzzy Sets and Sytems, 56, 97-101.
- [6] Sönmez, D., Yeşilot, G., Onar, S., Ersoy, B. A., Davvaz, B. (2017), On 2-Absorbing Primary Fuzzy Ideals of Commutative Rings, Article ID: 5485839, 7 pages.

Hermite-Hadamard Type Inequality for Strongly Log-convex Functions via Sugeno Integrals

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Abstract

Aggregation is a process of combining several numerical values into a single one which exists in many disciplines, such as image processing, pattern recognition and decision making. To obtain a consensus quantifiable judgment, some synthesizing functions have been proposed. For example, arithmetic mean, geometric mean and median can be regarded as a basic class, because they are often used and very classic. However, these operators are not able to model an interaction between criteria. For having a representation of interaction phenomena between criteria, fuzzy measures have been proposed [5]. In recent years, some authors generalized several classical integral inequalities for fuzzy integral. Li, Song and Yue [4] served Hermite-Hadamard type inequality for Sugeno integrals. Caballero and Sadarangani [3] showed Hermite-Hadamard type inequality of fuzzy integrals for convex function. A stronger property of convexity is log-convexity. The arithmetic mean-geometric mean inequality easily yields that every log-convex function is also convex. The behavior of certain interference-coupled multiuser systems can be modeled by means of logarithmically convex (log-convex) interference functions [2]. Abbaszadeh et al [1] estimated the upper bound of Sugeno fuzzy integral for log-convex functions using the classical Hadamard integral inequality. Turhan et al [6] obtained Hermite-Hadamard type inequality for strongly convex functions via Sugeno Integrals. In the light of these developments, our aim of this paper is to prove a Hermite-Hadamard type inequality for Sugeno integrals based on strongly log-convex functions that is an important extension of log-convexity. Some examples are given to illustrate the validity of the proposed inequality

Keywords: *Hermite-Hadamard Inequality, Strongly Log-convex Function, Sugeno Integral*

References

- [1] Abbaszadeh, S., M. Eshaghi and M. de la Sen. (2015) The Sugeno fuzzy integral of log-convex functions, Journal of Inequalities and Applications, 1, 1-12.
- [2] Boche, H, Schubert, M. (2008) A calculus for log-convex interference functions. IEEE Trans. Inf. Theory 54, 5469-5490.
- [3] Caballero, J., Sadarangani, K. (2009) Hermite-Hadamard inequality for fuzzy integrals, Appl. Math. Comput. 215, 2134-2138.
- [4] Li, D-O., Song, X-Q., Yue, T. (2014) Hermite-Hadamard type inequality for Sugeno integrals, Appl. Math. Computation. 237, 632-638.
- [5] Sugeno, M. (1974) Theory of fuzzy integrals and its applications (Ph.D. thesis), Tokyo Institute of Technology.
- [6] Turhan S., Okur N., Maden S. (2017) Hermite-Hadamard Type Inequality for Strongly Convex Functions via Sugeno Integrals. Sigma J. of Eng. and Natural Sci., 8 (1), 1-10.

Improving Fuzzy C-Means Clustering via Weighted Superposition Attraction Algorithm

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Abstract

Fuzzy clustering has become an important research field in pattern recognition and data analysis. As supporting unsupervised mode of learning, fuzzy clustering brings about unique opportunities to reveal structural relationships in data. Among fuzzy clustering methods, fuzzy c-means clustering is one of the widely preferred algorithm mainly due to its simplicity and practicality. Despite its many advantages, fuzzy c-means clustering algorithm has a major drawback that it can fall into local optima. In order to overcome this shortcoming, several optimization-based fuzzy clustering procedures have been suggested in the related literature. In the present study, a metaheuristic algorithm is employed in order to enhance accuracy of fuzzy c-means algorithm over traditional partition-based clustering methods. Weighted Superposition Attraction Algorithm (WSA) is a novel swarm intelligence algorithm, inspired from the superposition principle of physics in combination with the attracted movement of agents. Recently, performance of WSA algorithm has been tested on unconstrained and constrained problems in continuous domains. Due to its high converging capability and practicality, in the present study, WSA algorithm has been employed in order to enhance performance of fuzzy-c means clustering. Comprehensive experimental studies have been conducted on synthetic and publicly available datasets obtained from UCI machine learning repository. The results have showed that WSA algorithm improves the traditional fuzzy c-means algorithm. The proposed approach offers promising results compared to fuzzy c-means clustering algorithm. As the other fuzzy clustering methods suffer from complex parameter tunings, large error rates, and etc., the proposed approach outperforms classical clustering algorithms in terms of accuracy and practicality.

Keywords: *Fuzzy C-Means Clustering, Metaheuristics, Pattern Recognition, Weighted Superposition Attraction.*

References

- [1] Bezdek, J. C., Ehrlich, R., Full, W. (1984). FCM: The fuzzy c-means clustering algorithm. *Computers & Geosciences*, 10(2-3), 191-203.
- [2] Baykasoğlu, A., Akpınar, Ş. (2017). Weighted Superposition Attraction (WSA): A swarm intelligence algorithm for optimization problems–Part 1: Unconstrained optimization. *Applied Soft Computing*. 56, 520-540.

Applying the Theory of Fuzzy Time Series in Forecasting of the Rate of USD / AZN

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Abstract

In this paper, forecasting of the currency quotation USD / AZN is considered using fuzzy time series (FTS). It provides a step by step description of the technique, which represents the construction of fuzzy term sets for the linguistic variable "exchange rate". [1,2]. There are statistical data on currency quotes from 2006 to 2015. Let's build a fuzzy model for forecasting currency quotes for 2016. First of all, we denote set U as the rate, which takes values in the positive numeric axis, taking into account during the considered time interval. The highest rate for US dollar to Azerbaijani manat during 2006-2015 is observed 0.8931. The lowest rate 0.7845 is observed in 2013. Then, we can take the resulting boundary values as a segment $U = [0.78, 0.89]$ and divide the set in intervals of the same length. [3]. Secondly, fuzzy sets A_i is identified for the linguistic variable "exchange rate" with the carrier $[0.78, 0.89]$. For each term-set the membership function is given in a discrete form. Then, the exchange rate obtained on step 1 is fuzzified and formatted in logical relations $A_i \rightarrow A_j$. Joining the logical relationships into groups and calculating of the resulting ratio $R(t)$. The obtained relations are used in the forecasting model (Model of Song and Chisom [3]): $A(t+1) = A(t) \circ R(t)$ where $A(t)$ is the known exchange rate of the year t ; $A(t+1)$ is a fuzzy set expressing the forecast exchange rate, i.e., the exchange rate of the next forecasted year $(t+1)$; $R(t)$ the corresponding ratios for the year t ; and the symbol \circ indicates "max – min" operator. Finally, predicting of the results, i.e., finding of the forecast rate for 2016 is processed and the results are defuzzified.

Keywords: FTS – fuzzy time series, Currency quote, Discrete fuzzy sets, Fuzzy relations, Forecasting of trends

References

- [1] Degtyarev, K. (2010). Forecasting of currency quotations using a modified stationary method based on fuzzy time series. Moscow, Russia: Mir.
- [2] Chen, S.M. (1996). Forecasting Enrollments Based on Fuzzy Time Series. Fuzzy Sets and Syst., 81, 311–319.
- [3] Song, Q., Chisom, B.S. (1993). Fuzzy time series and its models. Fuzzy Sets and Syst., 54, 269–277.

Comparison of Different Price Formation Models in Double Auctions

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Abstract

In this paper we present design and comparisons of six new bidding strategies for seller and buyer agents participating in an agent-based continuous double auction. Four of these bidding strategies based on price targeting and two of these bidding strategies are based on fuzzy logic. In double auction markets prices form through the bargaining process of buyers and sellers which act according to their bidding strategies. Therefore a bidding strategy can also constitute a price formation model. For each micro bidding strategy macro market outcomes such as market efficiencies, price means, price standard deviations, profits of sellers and buyers, transaction quantities, profit dispersions and Smith's alpha statistics are measured using numerous agent based simulations and these outcomes' means are compared using t-tests. Spearman's rank order correlation coefficients between each outcome pairs are presented. Positive or negative relationships between each pair of these market outcomes are depicted and outcomes of successful strategies are characterized. It is shown that strategy rankings in different outcomes are consistent with each other. Also for relevant price formation models (bidding strategies) effects of initial parameter values on market efficiency are investigated.

Keywords: Double Auction Market, Bidding Strategies, Bargaining, Fuzzy Logic.

References

- [1] Cliff, D. (1997). Minimal-Intelligence Agents for Bargaining Behaviors in Market-Based Environments (Report No: HPL-97-91). Bristol, UK: Hewlett-Packard Labs.
- [2] Friedman, D. (1991). A simple testable model of double auction markets. *Journal of Economic Behavior & Organization*, 15(1), 47-70.
- [3] Friedman, D., & Rust, J. (Eds.). (1993). *The double auction market: institutions, theories, and evidence*. Cambridge, MA: Perseus Publishing.
- [4] He, M., Leung, H. F., & Jennings, N. R. (2003). A Fuzzy-Logic Based Bidding Strategy for Autonomous Agents in Continuous Double Auctions. *Knowledge and Data Engineering, IEEE Transactions on*, 15(6), 1345-1363.
- [5] Rust, J., Miller, J. H., & Palmer, R. (1994). Characterizing effective trading strategies: Insights from a computerized double auction tournament. *Journal of Economic Dynamics and Control*, 18(1), 61-96.

Using Fuzzy Logic for Automobile Pricing

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Abstract

Pricing an automobile requires the consideration of many factors. Although we know that the price of an automobile is related with some of its properties, many people are confused about the price of the automobiles they want to buy or sell if they do not have some knowledge on the automobiles they are interested in. In this study, we propose a fuzzy logic-based approach for automobile pricing using several properties of automobiles where the inputs and the output are defined as the corresponding properties and the price of the automobile, respectively. To design the fuzzy logic methodology, we first analyze a dataset obtained from the Laboratory of Artificial Intelligence and Computer Science of the University of Porto (LIACC) (<http://www.liacc.up.pt/~ltorgo/Regression/DataSets.html>) to determine the relationships between the price of an automobile and some of its properties such as the size of the vehicle (i.e., length, width etc.) and some specifications about the engine (engine-size, horse power etc.). By analyzing the dataset, we note the corresponding relationships between the price and some of the properties of an automobile. After determining these relationships, we define the membership functions for the inputs (properties) and the output (price) of the system. We finally relate the inputs and the output using the proposed fuzzy logic methodology. The same dataset is also used to test our methodology. We define several price categories covering the prices of the cheapest and the most expensive automobiles, and then, use the proposed fuzzy logic methodology for pricing. If the estimated price category falls into the correct category, (i.e., the category of the price of the automobile falls into), it is defined as a correct classification. Our findings imply that the proposed fuzzy logic methodology produces satisfactory results to be used for automobile pricing. A more comprehensive analysis on the inputs might increase the quality of results and a decision support tool for automobile pricing can be developed by extending the proposed methodology in future studies.

Keywords: *Automobile pricing, Pricing models, Fuzzy logic, Artificial intelligence*

References

- [1] Iseri, A., Karlık, B. (2009). An artificial neural networks approach on automobile pricing. *Expert Systems with Applications*, 36(2), 2155-2160.
- [2] Wilson, I. D., Paris, S. D., Ware, J. A., Jenkins, D. H. (2002). Residential property price time series forecasting with neural networks. *Knowledge-Based Systems*, 15(5), 335-341.

Fuzzy Decision Tree Based Anomaly Classification Method for X-Ray Images

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Abstract

Nowadays after the production phase of the industry, the automatic control of the products, whether they are defective or not, is a very important issue. In this context, the recommendation of solutions based on image based defect control of the products is found in the literature quite frequently. The proposed image-based solution can be applied on x-ray typed images as well as on images obtained with any rgb recordable imaging device [1]. The proposed solution can be achieved only by classical image processing based algorithms and by detecting anomalies on the image. Classification of the anomalies detected by such image processing algorithms running on X-ray images increases the efficiency of the solution proposal to be used for defect detection. In computer science, there are many methods and methodologies used to perform classification according to certain feature extraction. Of course, image-based feature extractions can also be used to perform the classification process. The image-based feature extraction performed in this study divides the x-ray image into logical areas of 10x10 pixels, calculates the weighted histogram averages of these logical areas, and compares each field with its neighboring areas and performs anomaly detection. Then we use the weighted histogram averages with each neighbor to classify the detected anomalies. Fuzzy decision trees can be used to perform the classification process according to certain feature extractions [2]. The classification process according to independent features can be performed with the decision trees. In the literature, there are studies that have been carried out in order to apply the classification process based on the cumulative data based feature extracts by using the fuzzy decision tree as in this study [3]. In the literature, however, there is a fuzzy logic based solution used on x-ray images [4]. In this study, the detection of anomalies is performed by using image processing techniques and histogram-based feature extraction on x-ray images and the fuzzy decision trees are used to classify the detected anomalies. The proposed solution was tested on Domingo Mery x-ray image dataset.

Keywords: *Fuzzy decision tree, X-ray images, Anomaly classification, Image processing.*

References

- [1] Merry D. (2015) Computer Vision for X-Ray Testing. Santiago, Chile: Springer.
- [2] Sardari S. Eftekhari M., (2016). A Fuzzy Decision tree approach for imbalanced data classification, Computer and Knowledge Engineering (ICCKE2016), 6th International Conference on. IEEE, pp.292-pp297.
- [3] Rabcan, J. (2016). Ordered Fuzzy Decision Trees Induction based on Cumulative Information Estimates and Its Application. In Emerging eLearning Technologies and Applications (ICETA), 2016 International Conference on 2016, pp. 295- pp. 301.
- [4] Shao Z., Liang L. (2013). Automatic Segmentation of Cracks in X-ray Image Based on OTSU and Fuzzy Sets 3rd International Congress on Image and Signal Processing. (CISP) pp.1824 – pp.1827.

Fuzzy Based Threshold Time Estimation for Shadow Transition in Reconfiguration Process of PV Arrays

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Abstract

Nowadays, solar panel systems from renewable energy sources are widely used for electricity generation. These systems provide users with significant advantages in electricity generation and offer cost effective solutions. However, there are some situations that negatively affect these systems. At the beginning of these cases are full or partial shadowing situations. There are various methods proposed in the literature in order to prevent this situation. One of these methods is the reconfiguration process. With the reconfiguration method, it is not necessary to change any physical location on the photovoltaic panel, only the electrical connections of the panels can be reconfigured and the replacement can be carried out. This process may overcome the negative effects generated by full or partial shadow occurring on photovoltaic panels. This process is performed through a switching matrix. The electrical connections of the panels connected to the switching matrix can be changed via the relays in this matrix. However, when this process is carried out, it is necessary to decide whether the shadows are temporary shadows or permanent shadows. Otherwise, the switching matrix will operate unnecessarily and cause energy loss in vain. In this paper, the full or partial shadows are determined by image processing on PV panels and it is decided by a fuzzy system that these shadows are temporary or permanent. Studies carried out in the literature generally operate without looking at the nature of the shadows and even in the slightest case of shadowing, the switching matrix is activated. With the proposed approach, a fuzzy approach has been realized that can come up from this situation and make a fast, accurate and reliable decision. In addition, the proposed approach verified the experimental test work, and the results obtained revealed the performance and accuracy of the system. This study has been supported by The Scientific and Technological Research Council of Turkey (TUBITAK 1001 Programme) under Research Project No: 112E214.

Keywords: *Image Processing, Fuzzy system, Partial Shading, Photovoltaic Systems, Reconfiguration.*

References

- [1] Patel, H., Agarwal, V., 2008. Maximum power point tracking scheme for pv systems operating under partially shaded conditions, IEEE Transactions on Industrial Electronics, 1689-1698, April 2008.
- [2] Baygin, M., Karakose, M., 2014. Image processing based analysis of moving shadow effects for reconfiguration in PV arrays, IEEE International Energy Conference (ENERGYCON), 683-987, 13-16 May 2014.
- [3] Nyugen, D., Lehman, B., 2008. An adaptive solar photovoltaic array using model-based reconfiguration algorithm, IEEE Transactions on Industrial Electronics, 2644-2655, July 2008.

A Fuzzy Weighted Shape Based Vehicle Detection Approach for Traffic Control

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Abstract

Detection and classification of vehicles is very important when traction is followed. It is not easy to track vehicles of different shapes and sizes moving in different environments. Especially in recent times, the image processing has been used extensively in traffic monitoring with the application of a very large area. Image processing algorithms used for different purposes such as vehicle counting, vehicle speed measurement and vehicle type detection are available in the literature. In this study, a shape-based approach using fuzzy logic is proposed for the detection of vehicles for traffic monitoring. The proposed algorithm is primarily based on the use of fuzzy logic to derive edge features, on-the-fly stance features and positioning features from the images taken from the camera. In the literature there are certain works for this purpose but their performances are at a certain level. Considering that the vehicles may be at different speeds and types, the use of blurred logic in this work ensures that the shapes and positioning of the vehicles are more accurately determined. The performance of the proposed method is presented with comparative results and the effectiveness of the method is demonstrated concrete. In order to verify the proposed approach, real vehicle images of different types from different angles were taken and tested. Experimental results are given for the method that works in high accuracy and in real life time.

Keywords: *Vehicle detection, Fuzzy logic, Traffic control, Image processing.*

References

- [1] Yumnah Hasan, Muhammad Umair Arif, Amad Asif, Rana Hammad Raza, Comparative Analysis of Vehicle Detection in Urban Traffic Environment using Haar Cascaded Classifiers and Blob Statistics, FTC 2016 - Future Technologies Conference 2016, pp. 547-552, San Francisco, United States, 6-7 December 2016.
- [2] Minhui Zhao, Chihang Zhao, Xingzhi Qi, Comparative analysis of several vehicle detection methods in urban traffic scenes, 2016 Tenth International Conference on Sensing Technology, pp. 1-4, 2016.
- [3] Canan Tastimur, Mehmet Karakose, Erhan Akın, Image processing based traffic sign detection and recognition with fuzzy integral, 2016 International Conference on Systems, Signals and Image Processing (IWSSIP), pp. 1-4, 2016.

A Fuzzy Decision Tree-Based Method for Classification of Satellite Images

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Abstract

Remotely sensed satellite images are a widely used data source with many advantages. Satellite imagery is often used for image classification because it contains many information about the earth [1]. Many methods have been used in the literature for image classification [2-4]. One of the image classification methods is decision trees. The decision tree method is a classification method that is used successfully in many areas according to its structure. In decision trees, a tree structure is first created that belongs to the data set. Then, classification is made using this tree structure. Decision trees are widely used in real-time applications because of their speed [2]. Decision trees are used together with the fuzzy system to obtain more successful results. Fuzzy decision trees are a method that is used effectively in the literature [5]. In this study, a fuzzy decision tree based method is proposed for classification of remote sensing images. In the proposed method, a fuzzy system is used to increase the success of decision trees. Fuzzy decision trees were developed using membership functions and rule table. The classical decision tree is compared with the fuzzy decision tree. The purpose of this study is to improve the classification performance of fuzzy decision trees. In addition, the effect of the fuzzy is tested for the data set used in decision tree formation. The developed fuzzy decision tree based image classification method is compared with existing methods in the literature. The advantages of the fuzzy system used in decision trees are given.

Keywords: Fuzzy decision trees, Satellite image, Remote sensing, Image classification

References

- [1] Ozturk, S. An experimental evaluation for fuzzy decision trees, Çukurova Üniversitesi Fen Bilimleri Enstitüsü Bilgisayar Mühendisliği Anabilim Dalı, pp. 1-124, 2015.
- [2] Kavzoglu, T., Colkesen, I. (2010). Karar Ağaçları İle Uydu Görüntülerinin Sınıflandırılması. Harita Teknolojileri Elektronik Dergisi, 2(1), pp. 36-45, 2010.
- [3] Karakose, M. Reinforcement learning based artificial immune classifier. The Scientific World Journal, 2013.
- [4] Alonso-Montesinos, J., Martínez-Durbán, M., del Sagrado, J., del Águila, I. M., Batlles, F. J. The application of Bayesian network classifiers to cloud classification in satellite images. Renewable Energy, 97, pp. 155-161, 2016.
- [5] Aydın, I., Karakose, M., Akin, E. An approach for automated fault diagnosis based on a fuzzy decision tree and boundary analysis of a reconstructed phase space. ISA transactions, 53(2), pp. 220-229, 2014.

A Case Study on Fuzzy Inference with Zadeh T-Operators by FID3-LR Classification Approach

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Abstract

The communication is based on words or sentences in real life. Human makes decision based on the information analyzed from these words or sentences. Linguistic variables carry the information based on fuzzy logic representation without loss. In this study, it is aimed to make a case study on inference phase of fuzzy decision tree approach working on L-R fuzzy data, named as FID3-LR (Fuzzy ID3 Algorithm for L-R Fuzzy Data). It is a mixture of FkM-F (Fuzzy k-means Clustering Model for Fuzzy data) [1] clustering algorithm and Fuzzy Interactive Dichotomizer 3 (Fuzzy ID3) [2] classification algorithm. Fuzzy k-means clustering model for fuzzy data (FkM-F) calculates distances based on weighted dissimilarity measure between the instances and centers of each attribute and it is used to obtain fuzzy membership degrees for each fuzzy term. This model generates a fuzzy decision tree on L-R fuzzy data by making the fuzzification directly. Then, the reasoning is performed by using the rules generated from fuzzy decision tree. The behaviour of Fuzzy ID3-LR with reasoning based on Zadeh operators is evaluated [3]. Fuzzy inference procedure is performed by using Zadeh T-Operators on four data sets chosen from the real-world databases (Wdbc, Pima, Sonar, Phoneme). Fuzzy ID3-LR are evaluated. It is seen that Wdbc has better results on FID3-LR with % 90.16 than other datasets. And, FuzzyID3-LR has accuracy rate with 74.03 for Sonar data set. As a result, FID3-LR algorithm proposed on the basis of Fuzzy ID3 algorithm works fundamentally on linguistic databases to solve the classification problems. And, the inference procedure is performed by using Zadeh T-Operators. Software called FuzzyArtemis is used to achieve the experimental study.

Keywords: *Fuzzy logic, Fuzzy decision tree, Classification, Linguistic data.*

References

- [1] Coppi, R, D'Urso, P., & Giordani, P. (2012) Fuzzy and possibilistic clustering for fuzzy data, *Computational Statistics and Data Analysis*, 56, 915-927.
- [2] Umano, M., Okamoto, H., Hatono, I., Tamura, H., Kawachi, F., Umedzu, S., & Kinoshita J. (1994). Fuzzy decision trees by fuzzy ID3 algorithm and its application to diagnosis systems. In *Proceedings of the third IEEE Conference on Fuzzy Systems*, 2113-2118.
- [3] Kantarcı S., Vahaplar A., Kınay A.Ö., Nasiboğlu, E. (2015b). Influence of different T-norm and T-conorm operators in fuzzy decision trees. In *Proceedings of 2015 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 1-6.

Fuzzy System Availability of a Battery Production System

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Abstract

Today's more complicated manufacturing systems make it difficult to analyze system performance accurately. System performance and measures such as failure rate, repair rate, reliability availability are used to analyze system and obtain system productivity. While aware application of system availability is for electrical and electronic systems, it has been started to use as a performance measure of manufacturing systems in recent years. Availability refers to the probability that a system or component is operating properly to its function at a specific point in time or a specific period of time, when operated and maintained in a prescribed manner. The conventional availability analysis relies on probability model and needs the precise values of system parameters such as failure and repair rates. However, in real life problems, it is generally difficult to obtain enough accurate historical data to estimate precise values of the system parameters. This study carried out on a multi-stage production line in a lead-acid battery production company in Turkey. In this study, because of insufficient and inaccurate historical data related with component failure and repair times of the considered system, we decided to define failure and repair data with fuzzy membership function. The exponential, triangular and trapezoidal membership functions are considered to represent these data and fuzzy system availabilities according to considered fuzzy functions are [0.6723, 0.9380], [0.8046, 0.8864] and [0.8046, 0.8864], respectively. Despite both triangular and trapezoidal membership functions have same intervals, trapezoidal fuzzy membership function has a flat line over an interval instead of single value for maximum degree of membership function. Moreover, trapezoidal membership function has narrower interval than exponential membership function. Thus, trapezoidal fuzzy membership function is more suitable for failure and repair data of the considered system to compute system availability.

Keywords: Fuzzy availability analysis, battery production system, fuzzy sets, membership function

References

- [1] Linmin Hu, Dequan Yue, Ruiling Tian (2015) Fuzzy Availability Assessment for a Repairable Multistate Series-Parallel System, Discrete Dynamics in Nature and Society, vol. 2015, pp. 1-12.
- [2] Verma, A. K., Srividya, A., & Prabhu, G. R. S. (2007) Fuzzy-reliability engineering: Concepts and applications. New Delhi: Narosa.
- [3] Medasani S., Kim J., Krishnapuram R. (1998) An Overview of Membership Function Generation Techniques for Pattern Recognition, International Journal of Approximate Reasoning, vol. 19, pp. 391-417.
- [4] Barua A., Mudunuri L. S., Kosheleva O. (2014) Why Trapezoidal and Triangular Membership Functions Work So Well: Towards a Theoretical Explanation, Journal of Uncertain Systems, Vol.8, No 3, pp.164-168.

Vague Soft Gamma Semigroup

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Abstract

Xu et al. introduced the concept of vague soft sets, which is an extension to the soft sets and fuzzy set. In this study, we give definition of vague soft gamma semigroup by applying the concept of vague soft set to gamma semigroup theory and give several properties it. Then we introduce the notion of vague soft ideal over a gamma semigroup. Intersection, union, AND and OR operations of vague soft ideals over gamma semigroup are defined. We define a vague soft homomorphism and show that homomorphic image and inverse image of vague soft gamma semigroup are also vague soft gamma semigroup and derive some results on them. Finally, some lattice structures of the set of all vague soft ideals of a gamma semigroup are derived.

Keywords: *Vague set, vague soft set, vague soft semigroup, vague soft gamma semigroup.*

References

- [1] L. A. Zadeh, "Fuzzy sets," Information and Control, vol. 8, no. 3, pp. 338–353, 1965.
- [2] D. Molodtsov, "Soft set theory-first results, Comput. Math. Appl., 37, 19-37, 1999.
- [3] W.L. Gau and D.J. Buehrer, "Vague Sets", IEEE Transactions on Systems, Man and Cybernetics 23(2), 610-614, 1993.
- [4] R. Biswas, "Vague groups", International Journal of Computational Cognition 4(2), 20-23, 2006.
- [5] W. Xu, J. Ma, S. Wang and G. Hao, "Vague Soft Sets and their properties, Computers and Mathematics with Applications 59, 787-794, 2010.
- [6] G. Selvachandran and A.R. Salleh, "Vague Soft Groups and Normalistic Vague Soft Groups", Comp. Math. Appl. 2011.
- [7] G. Selvachandran and A.R. Salleh, "Vague Soft Rings and Vague Ideals", Int. J. Algebra, 2012.
- [8] N.K. Saha, "On Γ -Semigroup II", Bull. Calcutta Math. Soc., 79, 331-335, 1987.
- [9] N.K. Saha, "On Γ -Semigroup III", Bull. Calcutta Math. Soc., 80, 1-13, 1988.

A Review of EEG Signal Processing Using Fuzzy Systems

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Abstract

In this paper, a lot of studies on the subject of electroencephalogram (EEG) signal analysis using fuzzy systems are presented. EEG signal indicates the brain activity. By examining the EEG signal, many brain related diseases can be diagnosed. Continuously, the study about EEG has great interest among researchers. A lot of studies have been done on EEG so far. In this study, the studies made with the fuzzy system are investigated. The use of fuzzy logic in EEG signal analyzing and classification have been surveyed. Among the viewed articles, it was seen that the fuzzy system, especially, was used to examine driver drowsiness, brain computer interface and epileptic activity. In this review, various feature extraction methods and result of different fuzzy techniques are discussed. The importance and the role of fuzzy logic in bioelectric signals processing are investigated. Thus, a lot of sources about fuzzy systems and EEG signal have been summarized for the researchers.

Keywords: EEG, Signal processing, Fuzzy Logic.

References

- [1] Lin, C. T., Chen, Y. C., Wu, R. C., Liang, S. F., and Huang, T. Y. (2005, May). Assessment of driver's driving performance and alertness using EEG-based fuzzy neural networks. In *Circuits and Systems, 2005. ISCAS 2005. IEEE International Symposium on* (pp. 152-155). IEEE.
- [2] Khushaba, R. N., Kodagoda, S., Lal, S., and Dissanayake, G. (2011). Driver drowsiness classification using fuzzy wavelet-packet-based feature-extraction algorithm. *IEEE Transactions on Biomedical Engineering*, 58(1), 121-131.
- [3] Kumar, Y., Dewal, M. L., and Anand, R. S. (2014). Epileptic seizure detection using DWT based fuzzy approximate entropy and support vector machine. *Neurocomputing*, 133, 271-279.
- [4] Jiang, Y., Deng, Z., Chung, F. L., Wang, G., Qian, P., Choi, K. S., and Wang, S. (2017). Recognition of Epileptic EEG Signals Using a Novel Multiview TSK Fuzzy System. *IEEE Transactions on Fuzzy Systems*, 25(1), 3-20.
- [5] Chai, R., Ling, S. H., Hunter, G. P., Tran, Y., and Nguyen, H. T. (2014). Brain-computer interface classifier for wheelchair commands using neural network with fuzzy particle swarm optimization. *IEEE Journal of Biomedical and Health Informatics*, 18(5), 1614-1624.
- [6] Nguyen, T., Khosravi, A., Creighton, D., and Nahavandi, S. (2015). EEG signal classification for BCI applications by wavelets and interval type-2 fuzzy logic systems. *Expert Systems with Applications*, 42(9), 4370-4380.

Evaluating Mental Work Load Using Multi-criteria Hesitant Fuzzy Linguistic Term Set (HFLTS)

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Abstract

Mental workload is the workload that plays a role in a number of complex command and control systems created by mental and perceptual activities such as calculation, decision making, communication, remembering, researching and searching. It is necessary to present the pressure amount on the employee caused by work in order to determine the mental workload. Mental workload measurement is important so that the employee can work more comfortably, satisfactorily and efficiently with normal performance without any exposure to this load. The NASA Task Load Index (NASA-TLX) one of the mental workload measurement methods, evaluates workload in terms of physical demand, mental demand, temporal demand, performance level, and effort level and failure dimensions. In this study, a new decision-making method, Hesitant Fuzzy Linguistic Term Set (HFLTS) is used, and Mental workload is evaluated by employing the dimensions used in NASA-TLX as criteria for the research assistants of engineering faculty. HFLTS provides a convenience with a rich set of linguistic terms for situations in which decision makers are hesitant to assess their criteria. The HFLTS method, which allows qualitative and quantitative criteria used in alternative evaluation to be assessed in a flexible and close way to unstable nature of the human being through a context-free grammar set of linguistic terms is a set of linguistic terms that has recently become the focus of attention. According to the results obtained in the study, proposals have been made to reduce the workload of research assistants.

Keywords: *HFLTS, NASA-TLX, Mental work load, Academic work load*

References

- [1] Rubio, S. Diaz, E. Martin, J. Puente, J.M. (2003). Evaluation of Subjective Mental Wrokload: A Comparison of SWAT, NASA-TLX, and Workload Profile Methods. *Applied Psychology*. 53(1), 61-86.
- [2] Farmer, E. and Brownson, A. (2003). Revier of workload measurement, analysis and interpretation methods. European Organisation for the Safety of Air Navigation.
- [3] Adem, A. Dağdeviren, M. (2016). A Life Insurance Policy Selection via Hesitant Fuzzy Linguistic Decision Making Model. *Procedia Computer Science*. 102, 398-405.

A Novel Learning Approach for Fuzzy Cognitive Maps: Relative Differential Hebbian Learning

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Abstract

Fuzzy Cognitive Maps have become an important soft computing tool for describing particular relationship between the concepts and the strength of these relations. There have been several learning approaches to determine the strength of relationships among the system concepts. Differential Hebbian Learning (DHL) has been one of the most widely used learning approaches in FCMs. In DHL, weight of a particular relationship between two concepts is updated according to the simultaneous change/difference in concept values between two iterations ($di \cdot dj$). In this study, DHL has been modified to produce less error. In the proposed approach weight update is performed according to the relative change which considers the percentage of difference/change where the difference is divided by the concept values. The error terms was compared with the results obtained from the proposed approach versus the results obtained from the Differential Hebbian algorithm. Based on the findings, the proposed algorithm appears promising with less error for the classical problems that are used widely for benchmarking purposes.

Keywords: *Fuzzy Cognitive Maps, Hebbian Learning, Relative Differential Hebbian Learning*

References

- [1] Kosko, B. (1986). Fuzzy cognitive maps. *International Journal of Man–Machine Studies*, 24, pp. 65–75.
- [2] Stylios, C.D. Groumpos, P.P. (2000). Fuzzy cognitive maps in modeling supervisory control systems. *Journal of Intelligent and Fuzzy Systems*, 8, (2), pp. 83–98.
- [3] White R.H. (1992). Competitive Hebbian learning: algorithm and demonstration. *Neural Networks*, 5, pp. 261–275.
- [4] Papageorgiou E.I., Stylios C.D., Groumpos P.P. (2003). Fuzzy cognitive map learning based on nonlinear Hebbian Rule, 16th International Conference on Artificial Intelligence, AI, Lecture Notes in Artificial Intelligence, 2903, Springer-Verlag, Berlin Heidelberg, pp. 254–266.
- [5] Hagiwara, M. (1992). Extended fuzzy cognitive maps. *IEEE International Conference in Fuzzy Systems*, 8–12 March, San Diego, CA, pp. 795–801.

Analysis of Fuzzy Supply Chain Performance on Buyback Contract Forms

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Abstract

Supply chain is basically the transport of goods from the beginning to the end of consumption. There are numerous members in the supply chain, including suppliers, retailers, distributors, etc. The presence of more than one firm in a supply chain affects supply chain performance negatively. All firms involved in the supply chain want to maximize their profits. The retailer wants to order small amount to increase its own profit while the supplier wants to produce too much to increase its own profit. Therefore, contractual agreements as coordination tools were established to increase the supply chain performance. There are numerous different types of contracts to coordinate supply chains; buyback contracts, revenue sharing contracts, quantity flexibility contracts, sales rebate contracts, quantity discount contracts, etc [1]. Among these contracts, buyback contract and revenue sharing contract are examined as most commonly studied ones in the literature. While managing the supply chains, there can be numerous types of uncertainties those should be overcome. In the literature, most of the studies deal with stochastic uncertainties about this subject. However, when there is lack of data and imprecision in the problem parameters, fuzzy models can be used for the problems. In this study, a two-stage supply chain coordination based on buyback contract and revenue sharing contract under fuzzy environment is examined. In buyback contract literature; this contract is distinguished five different scenarios to analyze supply chain performance by changing buyback rate and buy back price parameters, such as; no buy-back, total buy-back at full value, total buy-back at partial value, partial buy-back at full value, partial buy-back at partial value [2],[3]. Firstly, different closed form solutions to the fuzzy buyback contract types are obtained by changing the buyback rate and buy back price. And then the effects of buyback rate and buy back price parameters of the buyback contract on supply chain performance are analyzed. After that the performance values of the revenue sharing contract and the buyback contract are compared.

Keywords: *Fuzzy supply chain management, fuzzy buyback contract, fuzzy revenue sharing contract, contract analysis.*

References

- [1] G. Cachon, Supply Chain Coordination with Contracts, Supply Chain Management: Decision, Coordination and Operations, In Handb. Oper. Res. Manag. Sci., Amsterdam, 2003, pp. 229-340.
- [2] B. Pastenack, Optimal pricing and return policies for perishable commodities, Marketing Science, no. 16, pp. 166-176, 1985.
- [3] H. Andreoni, Supply Chain Coordination with Contracts, Wien, 2011.

A New Approach for Classification Problems: Use of Fuzzy Cognitive Maps with Binary Squeezing Functions

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Abstract

Fuzzy Cognitive Maps have been widely used for clustering analysis in the literature however their use for classification has been very limited. Current approaches extensively based on construction of a dummy concept which represents the membership of a case to a certain class. On the other hand, while concepts take a value between 0-1; a threshold/cut off value is required for assigning a case to a certain class. In the most of the FCMs a concept can be partially active therefore continuous squeezing functions are used to transform the sum of the inputs to a value between 0 and 1. However in classification problems, a binary activation function can be used to determine whether a case belongs to a class or not. In this regard, this paper proposes to employ a binary squeezing function to directly assign a case to a certain class. Thereby it is expected to overcome the difficulties to determine a cutoff value for a class.

Keywords: *Fuzzy Cognitive Maps, Classification, Binary Activation Function*

References

- [1] Kannappan, A., Tamilarasi, A. and Papageorgiou, E.I. (2011). Analyzing the performance of fuzzy cognitive maps with non-linear hebbian learning algorithm in predicting autistic disorder. *Expert Systems with Applications*. 38(3), pp. 1282–1292.
- [2] Papageorgiou, E.I. and Salmeron, J.L. (2013). A Review of Fuzzy Cognitive Maps Research During the Last Decade. *IEEE Transactions on Fuzzy Systems*. 21(1), pp. 66–79.
- [3] Papageorgiou, E.I., Spyridonos, P.P., Glotsos, D.T., Stylios, C.D., Ravazoula, P., Nikiforidis, G.N. and Groumpos, P.P. (2008). Brain tumor characterization using the soft computing technique of fuzzy cognitive maps. *Applied Soft Computing*. 8(1), pp. 820–828.
- [4] Papakostas, G.A., Koulouriotis, D.E., Polydoros, A.S. and Tourassis, V.D. (2012). Towards Hebbian learning of Fuzzy Cognitive Maps in pattern classification problems. *Expert Systems with Applications*. 39(12), pp. 10620–10629.
- [5] Song, H.J., Miao, C.Y., Wuyts, R., Shen, Z.Q., D'Hondt, M. and Catthoor, F. 2011. An Extension to Fuzzy Cognitive Maps for Classification and Prediction. *IEEE Transactions on Fuzzy Systems*. 19(1), pp. 116–135.

An Identification of a Fuzzy Measure which is Subadditive over Singletons

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Abstract

In multicriteria decision making (MCDM) problems fuzzy measure theory plays an important role. However, because of the exponential number of the subsets this approach is not an easy way. In this talk to relieve this complexity we consider a particular set function that depends on densities with interdependence coefficients and which provides redundancy among the singletons. We investigate the Möbius representation of this function. Finally, we support our work with explanatory numerical MCDM examples.

Keywords: *Möbius representation, multicriteria decision making*

References

- [1] Larbani, M., Huang, C. and Tzeng, G. (2011). A novel method for fuzzy measure identification. *International Journal of Fuzzy Systems*, 13.
- [2] Tzeng, G. H. and Huang, J. J. (2011). *Multiple attribute decision making, methods and applications*. CRC Press, Taylor and Francis Group, Boca Raton FL.
- [3] Chateaufneuf, A. and Jaffray, J. Y. (1989). Some characterizations of lower probabilities and other monotone capacities through the use of Möbius inversions. *Mathematical Social Sciences*, 17.

A Hesitant Fuzzy Approach for Ranking of European Countries in Terms of Healthcare Services

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Abstract

Development level of countries is determined by some indicators. These indicators are published regularly by worldwide organizations. There are too many indicators of development and some indicators can show the development level in terms of a specific subject. On the other hand, different indicators may show the development level in the same subject and to obtain a rank of countries, indicators related to this subject must be considered in an aggregated manner. By this way, a correct assessment of development can be done. Also, importance degrees of indicators are not usually equal and importance degree of each indicator should be taken into account. In this study, development ranking of countries in terms of healthcare services is considered as a multiple criteria decision making problem. The main aim in this study is to propose an analytic approach to rank countries in terms of indicators related to healthcare services. With this aim, a hybrid approach based on Hesitant Fuzzy Sets, Analytic Hierarchy Process (AHP) and Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) is proposed. Moreover, changes in the ranking of countries by using different hesitant fuzzy distance measures in TOPSIS is analyzed. Rankings obtained by using different distance measures are compared.

Keywords: *Hesitant Fuzzy Sets, AHP, TOPSIS, Healthcare Services*

References

- [1] Yavuz, M., Oztaysi, B., Onar, S. C., Kahraman, C.. (2015). Multi-criteria evaluation of alternative-fuel vehicles via a hierarchical hesitant fuzzy linguistic model. *Expert Systems with Applications*, 42, 2835-2848.
- [2] Xu, Z., Zhang, X.. (2013). Hesitant fuzzy multi-attribute decision making based on TOPSIS with incomplete weight information. *Knowledge-Based Systems*, 52, 53-64.
- [3] Liao, H., Xu, Z., Zeng, X. J.. (2014). Distance and similarity measures for hesitant fuzzy linguistic term sets and their application in multi-criteria decision making. *Information Sciences*, 271, 125-142.
- [4] Xu, Z., Xia, M.. (2011). On Distance and Correlation Measures of Hesitant Fuzzy Information. *International Journal of Intelligent Systems*, 26, 410-425.

A Fuzzy Approach for Product Selection Considering Universal Design Principles: A Case Study for Military Gas Mask Selection

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Abstract

The selection of the best product is the first step towards success for usage aim. Products provide the business with the most important and visible contact with buyers i.e. users. For this reason, the suitability of the selected product for the users is very important in terms of usage. In this context, universal design principles that aim to provide flexibility, easy use, practicality for all kinds of people such as, older, children, younger, people with disabilities, pregnant women etc. has a vital role in product selection. Universal design is also important for people who work for special aims such as soldiers, doctors etc. These kinds of people should use related products effectively. Due to this, universal design principles and relations between these principles should be considered for the selection in a scientific way. In this study, fuzzy logic is combined with Analytic Hierarchy Process (AHP) and Multi Attributive Border Approximation Area Comparison (MABAC) to model the human thinking system in product selection process. In this system, linguistic data take a huge place that covers vagueness and uncertainty. Besides, the product selection has a multi criteria decision making problem structure where the different criteria are considered for different alternatives by different decision makers. The proposed approach is utilized for military gas mask selection. In this context five gas mask alternatives are compared considering seven universal design principles. The proposed approach is an advanced approach took into consideration relation between criteria for computing importance weight of the criteria by using AHP and the method is reflected in defining a distance of criterion function of each observed alternative from the border approximate area by using MABAC. The border approximate area is defined by a separate procedure for each criteria and depends on the value of all alternatives according to the observed criteria.

Keywords: *AHP, MABAC, Fuzzy logic, Product selection*

References

- [1] Božanić, D. I., Pamučar, D. S., & Karović, S. M. (2016). Application the MABAC method in support of decision-making on the use of force in a defensive operation. *Tehnika*, 71(1), 129-136.
- [2] Nocco, A., Ottaviano, G. I., & Salto, M. (2017). Monopolistic competition and optimum product selection: why and how heterogeneity matters. *Research in Economics*.
- [3] Lenker, J. A., Lien, L., Nasarwanji, M., Feathers, D., & Paquet, V. (2016). Universal design as a conceptual framework for describing usability of products and environments: an applied example using the kitchen environment. *Journal of Design Research*, 14(3), 219-240.
- [4] Elahi, F., Muqtadir, A., Anam, S., & Mustafiz, K. (2017). Pharmaceutical Product Selection: Application of AHP. *International Journal of Business and Management*, 12(8), 193.

Hesitant Fuzzy Linguistic VIKOR Method for e-Health Technology Selection

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Abstract

Delivering healthcare services to patients is a complex and information-intensive activity. Medical devices and e-Health solutions have the potential to improve patients' lives through efficient utilization of information. e-Health is the use of information and communication technologies (ICT) for health. There are a number of significant e-Health technologies and emerging healthcare information technologies [1]. Because of rapidly changing technologies, new technology alternatives, and high technology investment costs, healthcare organizations may face difficulties in selecting the right technology. While doing this selection; there are a number of factors that must be taken into account, such as the cost of the technology, ease of use, useful life, and reliability. For this reason, this study proposes a multi-criteria decision making (MCDM) approach to support healthcare decision-making. It implements hesitant fuzzy linguistic term sets (HFLTS) for an effective e-Health technology evaluation problem as a standardized methodological approach. HFLTS enables decision makers (DMs) to easily present their linguistic expressions during the decision-making processes [2]. Thus, the purpose of this study is to provide a decision-making approach which will help the problem of selecting the most appropriate technology for healthcare institutions. An integrated HFL SAW method (Simple Additive Weighting) and HFL VIKOR (which stands for 'VlseKriterijumska Optimizacija I Kompromisno Resenje,' meaning multi-criteria optimization and compromise solution) methodology are utilized. The criteria weights are calculated by applying the HFL SAW method [3]. HFL VIKOR method is used for obtaining the final technology ranking results [4]. A case study about e-Health technology is given to demonstrate the potential of the approach.

Keywords: *e-Health, Technology Selection, Hesitant Fuzzy Linguistic Term Sets, Multi-criteria decision making, VIKOR*

References

- [1] Rahmani, A. M., Gia, T. N., Negash, B., Anzanpour, A., Azimi, I., Jiang, M., & Liljeberg, P. (2017). Exploiting smart e-health gateways at the edge of healthcare internet-of-things: a fog computing approach. *Future Generation Computer Systems*.
- [2] Rodriguez, R. M., Martinez, L., & Herrera, F. (2012). Hesitant fuzzy linguistic term sets for decision making. *IEEE Transactions on Fuzzy Systems*, 20(1), 109-119.
- [3] Chou, S. Y., Chang, Y. H., & Shen, C. Y. (2008). A fuzzy simple additive weighting system under group decision-making for facility location selection with objective/subjective attributes. *European Journal of Operational Research*, 189(1), 132-145.
- [4] Zhang, N., & Wei, G. (2013). Extension of VIKOR method for decision making problem based on hesitant fuzzy set. *Applied Mathematical Modelling*, 37(7), 4938-4947.

Fuzzifying Topology Induced by Fuzzy Metric

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Abstract

In this work, we present another approach of fuzzifying topology induced by fuzzy metric. Then we study its characteristicall properties and investigate some topological concepts such as fuzzy continuity of a map and fuzzy convergence of a sequence.

Keywords: *Fuzzifying topology, Continuous mapping of fuzzifying topological spaces, Convergence*

References

- [1] George A. and Veeramani P. (1994). On some results in fuzzy metric spaces. Fuzzy sets and systems, 64.3, 395-399.
- [2] Shostak, A. (1989). Two decades of fuzzy topology: basic ideas, notions and results. Russ. Math. Surv. (44), 125-186.
- [3] Mardones-Pérez, I., and Prada Vicente M.A. (2015). Fuzzy pseudometric spaces vs fuzzifying structures. Fuzzy Sets and Systems, (267), 117-132.
- [4] Kramosil, I. and Michálek. J. (1975). Fuzzy metrics and statistical metric spaces. Kybernetika, 11.5, 336-344.
- [5] Ying, M. (1991). A new approach for fuzzy topology-I. Fuzzy sets and systems, (39) 303-321.
- [6] Hohle, U. (1980) Upper semicontinuous fuzzy sets and applications, J. Math. Anal. Appl. (78) 659-673.

Fuzzy Revenue for Linear and Quadratic Demand Functions Using Trapezoidal Fuzzy Numbers

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Abstract

In this paper, we obtain the optimal revenue for the linear demand function $p(x) = \tilde{a} - x\tilde{b}$ and quadratic demand function $p(x) = \tilde{a} - x\tilde{b} \mp x^2\tilde{c}$, where x is a crisp quantity and $\tilde{a}, \tilde{b}, \tilde{c}$ are trapezoidal fuzzy numbers. We use signed distance defuzzification method and graded mean defuzzification method in order to defuzzify the demand function and the revenue function. Then we give a numerical example which shows that our trapezoidal fuzzy model gives more optimum results than the triangular fuzzy model.

Keywords: *Trapezoidal Fuzzy Number, Signed Distance Defuzzification Method, Graded Mean Defuzzification Method, Optimal Revenue*

References

- [1] Chang S.-C., Yao J.-S., Optimal revenue for demand function in fuzzy sense, Fuzzy Sets and Systems, 111(2000) 419-431.
- [2] Yao J.-S., Wu K., Ranking fuzzy numbers based on decomposition principle and signed distance, Fuzzy Sets and Systems 116 (2000) 275-288.

Life Insurances Decision Making Problem

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Abstract

In this study, we give a new application notion of a fuzzy soft set to selection of the most suitable life insurance considering the factors affecting life insurance. Then we propose a neural network model using this application.

Keywords: *fuzzy soft set, life insurance, neural network.*

References

- [1] Maji, P. K., Biswas, R. and Roy, A. R. (2001). Fuzzy soft sets. J. Fuzzy Math., 9, 589.-602.
- [2] Kalaichelvi, Dr. A. and Malini, P. H. (2011). Application of fuzzy soft sets to investment decision making problem. International Journal of Mathematical Sciences and Applications, 1(3), 1583.-1586.
- [3] Özgür, N. Y. and Taş, N. (2015). A note on "application of fuzzy soft sets to investment decision making problem. Journal of New Theory, 1(7), 1.-10.
- [4] Taş, N., Özgür, N. Y., Demir, P. An application of soft set and fuzzy soft set theories to stock management. in press.
- [5] Kunreuther, H. and Pauly, M. (2006). Insurance decision-making and market behavior. Foundations and Trends® in Microeconomics, 1(2), 63.-127.
- [6] Chaudhuri, A., De, Dr. K. and Chatterjee, Dr. D. (2009). Solution of the decision making problems using fuzzy soft relations. International Journal of Information Technology, 15(1), 29 page.

On the Note of History: Antecedents of Fuzzy Integrals in Ukrainian Mathematics

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Abstract

In the theory of fuzzy sets, several notions of integral were developed. In the historical perspective, one can mention the definitions by Sugeno, Ralescu&Adams, Zi_Xiao, Butnariu, and others. However, starting from 1962, before the famous work of Lotfi A. Zade (1965) was published, integrals which can be viewed as prototypes of fuzzy integrals were proposed by Ukrainian mathematicians Goldberg, Levin, Matsaev, and others. The talk presents an overview of their approaches.

Keywords: *Semi-additive measure, Entire function, history of mathematics*

References

- [1] Zadeh, L.A. (1965). Fuzzy sets. Inf. Control 8, pp. 338-353.
- [2] Goldberg, A. A.. (1962). The integral over a semi-additive measure and its application to the theory of entire functions. I, II. Math. Sbornik 58(100), pp.-pp. 334-349.

Optimization of Nonstationary Fuzzy Logic Systems with Genetic Algorithm for Cyber-Physical Systems

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Abstract

As it known, type-2 fuzzy systems are used because type-1 fuzzy systems are not adequate to handle uncertainties [1]. But their high computational burden makes it useless in real-time applications. Several approaches have been proposed in the literature for reducing this complexity. Nonstationary fuzzy systems which is based on using more than one type-1 fuzzy cluster in the same membership function is one of them [2]. Nonstationary fuzzy systems consist of many of fuzzy sets whose distributions are similar. But each fuzzy set can be different from each other, and the optimal limits of each fuzzy set should be adjusted for each different application [3]. There is no recommended study for the use of nonstationary fuzzy systems in this way in the literature. In this study, it is aimed to adjust the base values of each type-1 fuzzy set of input-output membership functions in nonstationary fuzzy systems. For this aim, an approach is proposed to optimize nonstationary fuzzy systems using genetic algorithm [4]. So that it will be able to have independent changes within the footprint of uncertainty, instead of a single-level change of current non-stationary fuzzy logic applications. In addition to optimizing type-1 fuzzy systems with genetic algorithms, methods are presented to optimize multiple fuzzy clusters in the same way and in relation to each other. For this purpose, performance of type-1, type-2 and nonstationary fuzzy systems is first compared and then performance of nonstationary fuzzy systems obtained by optimization is compared with other fuzzy systems. In particular, the performance of nonstationary fuzzy systems, which are more effective in modeling uncertainty than that of type-1 fuzzy systems, is further enhanced and the computational complexity is further reduced compared to the type-2 fuzzy systems. By comparing the performance of the proposed approach with simulation and experimental studies, comparative results are obtained for different applications.

Keywords: *Nonstationary fuzzy system, Genetic algorithm, Optimization, Cyber physical systems.*

References

- [1] J. M. Mendel (2017). Type-2 Fuzzy Sets. Uncertain Rule-Based Fuzzy Systems, Springer International Publishing, pp. 259-306.
- [2] J. M. Garibaldi, M. Jaroszewski, and S. Musikasuwan (2008). Nonstationary Fuzzy Sets. IEEE Transactions on Fuzzy Systems, 16(4), pp. 1072-1086.
- [3] H. Yetis, M. Karakose (2016). A Comparison of Nonstationary Fuzzy Logic for Cyber-Physical Systems. International Conference on Advances and Innovations in Engineering (ICAIE), pp. 929-933.
- [4] H. Yetis, M. Baygin, M. Karkose (2016). A New Micro Genetic Algorithm Based Image Stitching Approach for Camera Arrays at Production Lines. The 5th International Conference on Manufacturing Engineering and Process.

Taguchi Orthogonal Arrays Based Fuzzy Modeling and Optimization of Reduced Graphene Oxide Properties

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Abstract

Chemical products' design is highly related to experimental studies, expert knowledge and heuristic design [1]. Heuristic optimization methods such as genetic algorithm, fuzzy logic, and particle swarm algorithm have begun to be used in the synthesis optimization of nano materials [2]. In nanotechnology industry, predicting and optimizing the nano materials properties is required to save the production cost and improve the production yield. This study proposes a novel approach to predict and optimize the reduced graphene oxide (rGO) properties via Taguchi orthogonal arrays based fuzzy optimization for effective raw material usage. The ID/IG ratios, crystallite size and carbon to oxygen ratio have been selected as rGO properties. One factor that each has two control levels and seven factors that each has three control levels affects the rGO properties. Graphite size (A), graphite (B), sodium nitrate amount (C), sulfuric acid (D), phosphoric acid (E), potassium permanganate amount (F), oven temperature (G) and mixture rate (H) were identified as factors effect on rGO properties. L18 (21*37) orthogonal arrays have been selected to obtain experimental results. Mamdani fuzzy rule based model has been chose to modeling the rGO properties with the use of MATLAB® version 2015a. The rGO properties have been modeled as a function of the factors effect on responses. Optimum factors levels have also been determined by Taguchi orthogonal arrays based fuzzy algorithm. The validation results show that the Taguchi orthogonal arrays based fuzzy algorithm is effective predicting and optimizing the rGO properties with use of factors' level. The results also show that heuristic techniques should be used to optimize nano materials properties for improving manufacturing process.

Keywords: *Fuzzy modeling, Graphene oxide, Taguchi design, Product design.*

References

- [1] Ng, L.Y., Chemmangattuvalappil, N.G., Ng, K.S.D. (2015). Robust Chemical Product Design via Fuzzy Optimization Approach. *Computers&Chemical Engineering*, 83, pp.186-pp.202.
- [2] Quyang, X., Quyang, J., Guo, F. (2015). Development of a fuzzy analytical network process to evaluate alternatives on vitamin B12 adsorption from wastewater. *Computers&Chemical Engineering*, 95, pp.123-pp.129.

An Application of Fuzzy Linear Programming Model with Zimmerman Method

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Abstract

Classical linear programming problems are studied with certain numbers and there is an uncertainty. This uncertainty has become linguistically more or less expressible by the fuzzy set theory proposed by Zadeh at 1965[1]. Linear programming tries to optimize a linear function while providing a linear equality or inequality constraints is known, many decision-making problems encountered in everyday life are formulated as Linear Programming problem. However, in most cases it is not possible to determine precisely the constraints or objective functions in linear programming problems. In such cases, fuzzy linear programming methods are used [2]. Zimmerman suggests a solution to a fuzzy linear programming problem in a symmetric structure whose objective function and constraints are fuzzy programming. Zimmermann suggested that a level Z request for the value of the objective function the decision maker would like to achieve, and that each of the constraints could be modeled as a fuzzy set [3]. In our work, the fuzzy linear programming model is also solved by applying the Zimmerman method. It is seen that improvement is obtained by comparing the results of linear programming model with fuzzy linear programming results.

Keywords: *Fuzzy Linear Programming, Linear Programming, Zimmerman Method*

References

- [1] Zadeh, L. A., Kacprzyk J. (1992) Fuzzy Logic for The Management of Uncertainty. New York, John Wiley&Sons Inc.
- [2] Bazaraa, S., J. J. Jarvis and H. D. Sherali (1990). John Wiley & Sons Inc. (2nd ed.), New York
- [3] Zimmermann, H.J. (1978). Fuzzy programming and linear programming with several objective functions. Fuzzy Sets and Systems, 1(1), 45-55.

A New Fuzzy Dynamic Adaptive Particle Swarm Optimization Method For Cardinality Constrained Portfolio Optimization

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Abstract

Optimum portfolio selection which is also named as portfolio optimization, refers to choosing from a given set of risky assets to form the best portfolio under certain assumptions and criteria [1]. The Cardinality Constrained Portfolio Optimization (CCPO) which is a mixed nonlinear integer programming problem mostly solved by heuristic algorithms due to lack of efficient exact algorithms [2]. Particle Swarm Optimization (PSO) is a swarm-based stochastic search algorithm which can produce better solutions and can be adapted to different types of problems easier than most of the heuristics [3]. While solving np-hard optimization problems, parameters of PSO can be adjusted through the iterations by self-adaptive or fuzzy adaptive methods to improve performance of the algorithm [4]. The proposed algorithm combines a fuzzy adaptive particle swarm optimization (FAPSO) algorithm with self-adaptive procedure. Fuzzy logic is used as a control mechanism of social learning while self-adaptive approach adjusts separately cognitive learning of each particle. The proposed approach and some other variants of PSOs and FAPSOs are tested on two different data sets and the proposed approach improves the performance of the FAPSO algorithm in CCPO.

Keywords: *Fuzzy Adaptive Particle Swarm Optimization, Cardinality Constrained Portfolio Optimization, Self-Adaptive.*

References

- [1] Markowitz, H. (1952). Portfolio selection. The journal of finance, 7(1), 77-91.
- [2] Cura, T. (2009). Particle swarm optimization approach to portfolio optimization. Nonlinear analysis: Real world applications, 10(4), 2396-2406.
- [3] Niknam, T. (2010). A new fuzzy adaptive hybrid particle swarm optimization algorithm for non-linear, non-smooth and non-convex economic dispatch problem. Applied Energy, 87(1), 327-339.
- [4] Melin, P., Olivas, F., Castillo, O., Valdez, F., Soria, J., and Valdez, M. (2013). Optimal design of fuzzy classification systems using PSO with dynamic parameter adaptation through fuzzy logic. Expert Systems with Applications, 40(8), 3196-3206.

Integrating Interval Type-2 Fuzzy DEMATEL and Analytic Network Process for 3PL Transportation Provider Evaluation

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Abstract

The Third-Party Logistics (3PL) is a critical decision for enterprises in achieving operational efficiency and service improvement. Proper management of 3PL providers helps enterprises reduce capital expenditures and logistics costs. 3PL provider evaluation is one of the most critical tasks in logistics management. Selecting most appropriate 3PL provider requires evaluation of incommensurate, conflicting, and multiple criteria. Thus, 3PL provider evaluation is a classical Multiple Attribute Decision Making (MADM) problem. As a result of inherent uncertainty in the linguistic assessments of decision makers, interval type-2 fuzzy (IT2F) sets play a critical role in modeling MADM problems. In this study, IT2F sets are employed in order to handle linguistic expressions of decision makers. On the other hand, there are possible interactions and dependencies among criteria in 3PL provider selection problem. For that reason, Analytic Network Process (ANP) is used in order to model interdependencies among criteria. As ANP requires many pairwise comparison questions to be filled out, a more practical approach namely Decision Making Trial and Evaluation Laboratory (DEMATEL) method is integrated into ANP by using IT2F environment. A computational study in 3PL provider selection is performed in order to illustrate applicability of the proposed method. The results show the stability and practicality of the proposed approach.

Keywords: *Analytic Network Process, Interval Type-2 Fuzzy Sets, DEMATEL Method, Logistics*

References

- [1] Gölcük, İ., Baykasoglu, A. (2016). An analysis of DEMATEL approaches for criteria interaction handling within ANP. *Expert Systems with Applications*, 46, 346-366.
- [2] Mendel, J. M., John, R. B. (2002). Type-2 fuzzy sets made simple. *IEEE Transactions on fuzzy systems*, 10(2), 117-127.
- [3] Liu, H. T., Wang, W. K. (2009). An integrated fuzzy approach for provider evaluation and selection in third-party logistics. *Expert Systems with Applications*, 36(3), 4387-4398.

Technical Assessment of FTTB Supplier in Telecommunication Industry Using Fuzzy AHP-VIKOR Approach with Interval Type-2 Fuzzy Sets

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Abstract

The Internet is crucial for variety of reasons, and it affects many fields of life. Fibre is the technology that ensures high speed internet connection. Moreover, Internet Service Provider (ISP) has various fibre solutions to provide customers with internet. Some of these solutions are Fiber To The Cabinet (FTTC), Fiber To The Home (FTTH) and Fiber To The Building (FTTB). FTTC is not useful enough because its content has a negative effect on DSL speed. FTTH system might have some installation problems and causes extra cost for old buildings. High speed fibre cable comes to FTTB system which is located inside of the buildings. This system, in which the existing lines are used, provides high speed internet without extra cost. In Turkey, the total number of internet customers have increased by 10,8% in the first period of 2017 compared to the last year's same period (BTK, 2017). Furthermore, 11% of these customers use the internet by FTTB system. ISPs ensure the FTTB systems to customers by establishing the FTTB access network device in their building. Technical suitability of this device is crucial for the quality of internet access. So, choosing the FTTB access network device is an important decision for the ISPs. ISPs supply the FTTB access network device from many producer firms as FTTB supplier. ISPs must evaluate plenty of criteria which might conflict with each other and choose best FTTB supplier. Producers also want to become most-preferred supplier in growing telecommunication industry. Therefore, it can be said that selecting an ideal FTTB provider is a kind of Multi-Criteria Decision-Making problem. The main of this study is to select FTTB supplier by Fuzzy AHP-VIKOR with interval type-2 fuzzy sets. In this context, Fuzzy AHP is used for calculating priority weights of each criteria and Fuzzy VIKOR is employed to achieve the final ranking of FTTB suppliers. The results indicate that the proposed method offers a consensus solution in supplier selection problem.

Keywords: *Fuzzy AHP, Fuzzy VIKOR, Type-2 Fuzzy Sets, Supplier Selection, Telecommunication.*

References

- [1] BTK (2017). Üç Aylık Pazar Verileri Raporu, 2017 Yılı 1. Çeyrek, Retrieved from https://www.btk.gov.tr/File/?path=ROOT%2f1%2fDocuments%2fSayfalar%2fPazar_Verileri%2f2017-1-Q1.pdf

Statistical Distribution Functions of Type-2 Fuzzy Numbers

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Abstract

Fuzzy sets are useful and effective tools to model the uncertainty problem in real-life applications. The most common fuzzy sets used in these applications are known as type-1 fuzzy sets (T1FSs). Since the degrees of membership of T1FSs are crisp numbers, recently, type-2 fuzzy sets (T2FSs) are also preferred by many researchers to express uncertainty in T1FSs. Zadeh (1975) introduced Type-2 fuzzy set (T2FS) as an extension version of the conventional T1FS. Some important studies about T2FSs can be given as Hamrawi (2011), Karnik and Mendel (2001). Furthermore, some applications of T2FSs can be found in Tao et al. (2012), Turksen (2002), Wagenknecht and Hartmann (1988). Also, basic operations on T2FSs were studied by Karnik and Mendel (2001). However, type-2 fuzzy numbers (T2FNs) are required to make theoretical inference about modelling uncertainty. In the literature, limited number of studies can be found related to the operations on T2FNs (Kardan et. al., 2014). Mostly, it is difficult to use these operators on T2FNs. Therefore, some mathematical operators which can be easily applied to T2FNs are given in this study. Also, mathematical functions of T2FNs are given according to their monotonicity. These functions are applied to Normal, Chi-square, Exponential distributions respect to monotonicity of the parameters of these distributions.

Keywords: *T2FNs, Membership function, Fuzzy probability distribution, Type-2 fuzzy parameters*

References

- [1] Hamrawi, H. (2011). Type-2 fuzzy alpha-cuts, PhD. Thesis. De Montfort University.
- [2] Zadeh, L.A. (1975). The concept of a linguistic variable and its applications in approximate reasoning (I). *Information Sciences*, 8, 199–249.
- [3] Kardan, I., Akbarzadeh-T, M. R., Akbarzadeh, A., Kalani, H. (2014). Quasi type 2 fuzzy differential equations. *Journal of Intelligent & Fuzzy Systems*, (Preprint), 1-13.
- [4] Karnik, N.N., Mendel, J.M. (2001). Operations on type-2 fuzzy sets. *Fuzzy Sets and Systems*, 122, 327–348.
- [5] Tao, C.W., Taur, J.S., Chang, C.W., Chang, Y.H. (2012). Simplified type-2 fuzzy sliding controller for wing rock system. *Fuzzy Sets and Systems*, 207, 111–129.
- [6] Türksen, I.B. (2002). Type-2 representation and reasoning for CWW. *Fuzzy Sets and Systems*, 127, 17–36.
- [7] Wagenknecht, M., Hartmann, K. (1988). Application of fuzzy sets of type-2 to the solution of fuzzy equations systems. *Fuzzy Sets and Systems*, 25, 183–190.

Type 2 Fuzzy Control Charts Using Ranking Methods

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Abstract

Control charts are important because they provide information about process and product. For this reason, control charts are used in many fields. Information about the process, which is under control or not, can be obtained by looking at the control charts. It may be encountered that there is a loss of information in the control charts generated by crisp numbers, especially for qualitative data. At this point, it is necessary to make use of the fuzzy logic which quantifies linguistic expressions. Studies of control charts with type 1 fuzzy numbers are available in the literature. There are no control charts in the literature regarding the cases where the data are expressed by type 2 fuzzy numbers. The purpose of this study is to examine whether the process is under control or not using the type 2 fuzzy ranking methods. The results are compared with the crisp control charts. This study aims to provide newness to the literature by using ranking method to generate type 2 fuzzy control charts, which is a different field.

Keywords: interval type-2 fuzzy control charts, fuzzy logic, type-2 fuzzy ranking.

References

- [1] Wu, D., Mendel, J.M. (2009). A Comparative Study of Ranking Methods, Similarity Measures and Uncertainty Measures for Interval Type-2 Fuzzy Sets, *Information Sciences*, 179, 1169-1192.
- [2] Chen, S.M., Lee, L.W. (2010). Fuzzy Multiple Attributes Group Decision-Making Based on the Ranking Values and the Arithmetic Operations of Interval Type-2 Fuzzy Sets, *Expert Systems with Applications*, 37, 824-833.
- [3] Chen, S.M., Yang, M.W., Lee, L.W., Yang, S.W. (2012). Fuzzy Multiple Attributes Group Decision-Making Based on Ranking Interval Type-2 Fuzzy Sets, *Expert Systems with Applications*, 39, 5295-5308.
- [4] Wang, W., Liu, X., Qin, Y. (2012). Multi-attribute Group Decision Making Models Under Interval Type-2 Fuzzy Environment, *Knowledge-Based Systems*, 30, 121-128.
- [5] Qin, J., Liu, X. (2015). Multi-Attribute Group Decision Making Using Combined Ranking Value Under Interval Type-2 Fuzzy Environment, *Information Sciences*, 297, 293-315.
- [6] Singh, P., Kumar, M., Kang, S.M. (2016). Ranking of Triangular Type-2 Fuzzy Sets and Its Application in Multicriteria Decision Making Problem, *International Journal of Pure and Applied Mathematics*, 109, 631-649.
- [7] Manvizhi, M., Latha, K., Thiripurasundari, K. (2017). Rank of Type-2 Triangular Fuzzy Matrix, *Imperial Journal of Interdisciplinary Research*, 3, 538-545.

Neuro-Fuzzy Based Model Reference Adaptive Control for Induction Motor Drive

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Abstract

An adaptive neuro-fuzzy inference system (ANFIS) based model reference adaptive control (MRAC) approach for vector controlled induction motor drive system is proposed in this paper. Due to the complex and nonlinear construction of induction motors, speed and torque controls are very difficult compared to direct current motors. To improve the speed control system of induction motors, a controller was developed by combining the ANFIS and MRAC structures. The use of the MRAC in the control scheme facilitates the analysis of the adaptive system and provides stability. The ANFIS is used to adaptively compensate for the plant nonlinearities. The adjustable parameters of the controller are updated online. A simulation model for indirect field-oriented control (IFOC) of the induction motor drive is developed using MATLAB/Simulink. The results of the developed controller are compared with the results of the conventional PI type controller to prove the success of the control method. The simulation environment, it is clearly shown that the proposed control structure is considerably successful from the results obtained by operating the induction motor under different conditions.

Keywords: *Induction Motor, ANFIS, MRAC, IFOC.*

References

- [1] Landau, I.D., Lozano, R., M'Saad, M., Karimi, A. (1998). Adaptive Control. Berlin, Springer.
- [2] Kilic, E., Ozcalik, H.R., Yilmaz, S. (2016). Efficient speed control of induction motor using RBF based model reference adaptive control method. *Automatika*, 57(3), 714-723.
- [3] Mechernene, A., Zerikat, M., Chekroun, S. (2010). Indirect field oriented adaptive control of induction motor based on neuro-fuzzy controller. *Proc. 18th Mediterranean Conference on Control and Automation (MED10) Marrakech*, pp. 1109-1114.
- [4] Jang, J.S. (1993). ANFIS: adaptive-network-based fuzzy inference system. *IEEE transactions on systems, man, and cybernetics*, 23(3), 665-685.

Training Fuzzy Neural Networks with Social Spider Algorithm

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Abstract

Inspired from the biological nervous systems artificial neural networks (ANNs) are simplified mathematical models of human brain. They automatically perform abilities of human such as learning, making new inferences and they are very successful in solving complex nonlinear problems. ANNs learn from examples and learning is achieved by training the network [1]. Many algorithms and methods are developed so far for this purpose. Among these methods and algorithms conventional algorithms are based on mathematical computation, slow and often trapped into local optima. Fuzzy neural networks and meta-heuristic algorithms are widely used in literature to overcome these disadvantages with their remarkable properties like learning accuracy, speed and generalization capability [2]. Fuzzy neural systems incorporate the fuzzy logic into the ANNs to deal with cognitive uncertainties like human brain. This can be done by fuzzifying input layer and inserting fuzzy logic operators into neural networks [3, 4, 5]. In this study artificial neural networks and fuzzy neural networks are trained with social spider algorithm [6] which is a novel meta-heuristic algorithm inspired from the social spider behaviors. Performances of the two algorithms are tested and compared on three classification benchmark datasets in machine learning area. Fuzzy neural networks outperform the artificial neural networks with higher classification accuracies.

Keywords: *Fuzzy neural networks, Artificial neural networks, Social spider algorithm, Classification*

References

- [1] Öztemel, E. (2012) Yapay Sinir Ağları (Artificial Neural Networks). Istanbul, Turkey: Papatya Publisher.
- [2] Zhenya, H., Chengjian, W., Luxi, Y., Xiqi, G., Susu, Y., Eberhart, R. C., & Shi, Y. (1998). Extracting rules from fuzzy neural network by particle swarm optimization. Evolutionary Computation Proceedings, IEEE World Congress on Computational Intelligence, The 1998 IEEE International Conference, 74-77.
- [3] Kulkarni, A., & McCaslin, S. (2006). Fuzzy neural network models for multispectral image analysis. Proceedings of the 5th WSEAS Int. Conf. on Circuits, Systems, Electronics, Control & Signal Processing, 66-71.
- [4] Ko, C. H., Pan, N. F., & Chiou, C. C. (2013). Web-based radio frequency identification facility management systems. Structure and Infrastructure Engineering, 9(5), 465-480.
- [5] Fuller, R. (1995) Neural Fuzzy Systems. Abo, Finland: Abo Academy University.
- [6] James, J. Q., & Li, V. O. (2015). A social spider algorithm for global optimization. Applied Soft Computing, 30, 614-627.

Prediction of Milk Yield Using Fuzzy Nonlinear Regression with Neural Networks

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Abstract

Fuzzy theory states that complexity and uncertainty dominate in nature and the analysis of fuzzy data in the real world indicates the necessity of using uncertainty methods. The uncertainty involved in nonlinear systems, the complexity of the equations and the difficulty in obtaining the solutions play an important role in the emergence of the fuzzy concepts. In this study, it is accepted that there are some nonspecific phenomena in the structure of the system in solving the problem of nonlinear regression analysis. An intelligent system with fuzzified characters at this point is expected to perform better than conventional methods. In this study, it is aimed to model milk production data by nonlinear fuzzy regression analysis. The results were compared with the Gamma function, which is an accepted model construction in the literature by using the RMSE and MAPE criteria. Neural networks designed with different training algorithms have been used to generate the prediction interval of nonlinear fuzzy regression analysis. Neural network analyses were performed with a nonlinear auto-regressive model with exogenous input (NARX). In this context, two different training algorithms are used, Bayesian Regularization and Levenberg-Marquardt. The data analysed during the five lactation periods were accepted as a time series. In the nonlinear fuzzy regression analysis process; information on the first four lactation periods was used to construct the model and information on the last lactation period was used to investigate the model validity. The results of the analysis show that neural network based nonlinear fuzzy regression analysis can be used as an alternative to traditional methods.

Keywords: *Nonlinear fuzzy regression, milk production, modelling, neural network.*

References

- [1] Ishibuchi, H., Tanaka, H. (1992). Fuzzy Regression Analysis Using Neural Networks: Fuzzy Sets and Systems, 50(3), 257-266.
- [2] Xu, Z., Khoshgoftaar, T. M., Allen, E. B. (2000). Prediction of software faults using fuzzy nonlinear regression modeling. In High Assurance Systems Engineering, 2000, Fifth IEEE International Symposium on. HASE 2000 (pp. 281-290). IEEE.
- [3] He Y L., Wang X Z.; Huang J Z. (2016). Fuzzy Nonlinear Regression Analysis Using A Random Weight Network. Information Sciences (364–365), 222-240.
- [4] Murphy, M. D., O'Mahony, M. J., Shalloo, L., French, P., Upton, J. (2014). Comparison of modelling techniques for milk-production forecasting. Journal of dairy science, 97(6), 3352-3363.

Design of Cursor Control Using EEG and IMU Sensor Fusion with ANFIS

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Abstract

In this paper, an Adaptive Neuro-Fuzzy System (ANFIS) is used for fusion of Electroencephalography (EEG) and Inertial Measurement Unit (IMU) sensors and it is aimed to perform cursor control with this system. The combination of EEG and IMU sensors is intended to perform cursor control by combining cognitive responses and head movements. Absolute systems are a method of calculating the position of a sensor placed on an object to be determined with respect to fixed references[1,2]. These systems produce very precise and accurate results, but the infrastructure costs are high and the installations are difficult. Relative positioning systems are cheap and simple systems. However, these systems can not compensate for errors caused by friction and noise, and they increase continuously as the working time increases. Biopotential sensors have been added to relative sensors in recent years. These sensors, unlike traditional sensors, aim to measure physiological changes of the living organism, rather than changes in the physical environment, and to provide an interaction with them. The most common biopotential sensors are EEG, Electrocardiography, and Electromyography [3–5]. The MPU6050 IMU sensor and the NeuroSky Mindwave EEG device were used. With the prepared recording program, the received data are recorded as separate program tasks and with time stamp. During the data collection phase, a cursor simulator was first prepared and the subjects were asked to follow this cursor setup for five minutes. Simulator, IMU and EEG tasks prepared for data collection are prepared. The simulator task records cursor position, speed and shape. With the IMU task, 3 axis acceleration and angular rotation are recorded. The data collected with the EEG task are frequency band amplitudes, attention, meditation and blinking values. In the ANFIS learning process, IMU and EEG data were input and simulator data was used as output. As a result, ANFIS cursor control is provided with 0.5% error.

Keywords: ANFIS, Human Machine Interface, EEG, IMU

References

- [1] Borenstein, J., Everett, H.R., Feng, L. ve Wehe, D.K. (1997) Mobile robot positioning: Sensors and techniques.
- [2] Gu, Y., Lo, A. ve Niemegeers, I. (2009) A survey of indoor positioning systems for wireless personal networks. IEEE Communications surveys & tutorials, 11, 13–32.
- [3] Moon, I., Lee, M., Chu, J. ve Mun, M. (2005) Wearable EMG-based HCI for electric-powered wheelchair users with motor disabilities. Robotics and Automation, 2005 ICRA 2005 Proceedings of the 2005 IEEE International Conference on, IEEE. s. 2649–2654.
- [4] Bi, L., Fan, X.-A. ve Liu, Y. (2013) EEG-based brain-controlled mobile robots: a survey. IEEE transactions on human-machine systems, 43, 161–176.
- [5] Seçkin, A.Ç. ve Seçkin, M. (2016) Giyilebilir Teknolojiler: Biyosensörler. International Conference on Computer Science and Engineering - UBMK 2016, UBMK. s. 855–8.

A Comparison of Conventional Statistical Regression Analysis and Fuzzy Regression

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Abstract

Regression analysis is a statistical technique for modeling and investigating the relationship between variables. The regression has many different fields of application such as engineering, medicine, physical, chemical, social, educational, economics and administrative sciences. Actually, the regression analysis is mostly used in statistical sciences. In the linear regression analysis, it is assumed that the relationship between the response variable and the independent variables is linear, the error term has zero mean and constant variance, and the errors are irrelevant and have normal distribution. In the conventional statistical regression model, residues between the observed and the estimated values are supposed to be due to observation errors. However, residues are sometimes caused by the indefiniteness of the system structure and we regard these residues as the fuzziness of system parameters. A fuzzy regression model is used to evaluate the functional relationship between the response and explanatory variables in a fuzzy environment. Most of the fuzzy regression models uses crisp (non-fuzzy) inputs and fuzzy outputs. In the fuzzy regression analysis, there are two approaches: linear programming and fuzzy least squares methods. In this study, for selected data, firstly, conventional statistical regression analysis were applied and then fuzzy regression. After that, we compared these methods with respect to their advantages and disadvantages.

Keywords: *Regression, fuzziness, fuzzy regression.*

References

- [1] Montgomery, D. C., Peck, E. A., & Vining, G. G. (2001). Introduction to linear regression analysis. Third Edition. John Wiley & Sons., New York, USA.
- [2] Tanaka, H., Uejima, S., & Asai, K., (1982). Linear regression analysis with fuzzy model, IEEE Transactions on Systems, Man, And Cybernetics, Vol. Smc-12, No.6, November/December 1982, pp.903-907
- [3] Ubale, A., & Sananse, S. (2016). A comparative study of fuzzy multiple regression model and least square method. International Journal of Applied Research, 2(7), 11-15.
- [4] Shapiro, A. F. (2005). Fuzzy regression models. Penn State University, 6, 12.
- [5] Hojati, M., Bector, C. R., & Smimou, K. (2005). A simple method for computation of fuzzy linear regression. European Journal of Operational Research, 166(1), 172-184.
- [6] Yang, M. S., & Lin, T. S. (2002). Fuzzy least-squares linear regression analysis for fuzzy input-output data. Fuzzy Sets and Systems, 126(3), 389-399.
- [7] Plaia, A.& Caggegi, G. (1997). Fuzzy set theory and linear regression analysis. Statistica Applicata Vol.9,n.1.pp.81-94., Italy.

Investigation of Breaking Force of Chenille Yarn Using Statistical Regression and Fuzzy Regression Analyses

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Abstract

There are many studies on tensile properties of standard yarn in the literature but there is a lack of studies on chenille yarn. Chenille yarn, which is a type of fancy yarn, consists of cut pile yarns compacted by twisting of two binder yarns. Tensile properties of yarn have a great effect on performance of textile products. One of the tensile characteristic of chenille yarns is breaking force. In this study, breaking force was investigated using statistical and fuzzy approaches. The results of statistical and fuzzy approaches were compared with each other and then also compared to theoretical approach. In the theoretical approach which was studied in [1], a mathematical prediction model was developed by using geometrical methods for breaking force of chenille yarn. The aim of this study is to explain the effect of selected production parameters and yarn components on tensile properties of chenille yarn using fuzzy logic method and to evaluate the performance of the methods. For this aim, 27 different chenille yarn samples were produced according to an experimental design which contains different levels of effective factors. In statistical approach, the data sets were divided into two parts of 20 and 7 sets. First data group was used in stepwise regression analysis and second data group was used for verification. As a result of regression analysis, it was seen that the significant effective factors on breaking force of chenille yarn are count of binder yarn and twist level of chenille yarn. So, count of binder yarn and twist level of chenille yarn are explanatory or independent variables and breaking force is dependent or response variable. Using these variables, regression analysis was applied again to compare the result of fuzzy regression. In the conventional statistical regression model, residues between the observed and the estimated values are supposed to be due to observation errors. However, residues are sometimes caused by the indefiniteness of the system structure and we regard these residues as the fuzziness of system parameters. A fuzzy regression model is used to evaluate the functional relationship between the dependent and independent variables in a fuzzy environment. Most of the fuzzy regression models uses crisp inputs and fuzzy outputs.

Keywords: Chenille yarn, breaking force, fuzzy regression, prediction.

References

- [1] İlhan, İ. (2017). Şönil ipliğin mukavemet ve uzama özellikleri üzerine deneysel bir çalışma. Tekstil Ve Konfeksiyon, 27 (2), 117-125. <http://dergipark.gov.tr/tekstilvekonfeksiyon/issue/30018/324083>
- [2] Tanaka, H., Uejima, S., & Asai, K., (1982). Linear regression analysis with fuzzy model, IEEE Transactions on Systems, Man, And Cybernetics, Vol. Smc-12, No.6
- [3] Ubale, A., & Sananse, S. (2016). A comparative study of fuzzy multiple regression model and least square method. International Journal of Applied Research, 2(7), 11-15.
- [4] Shapiro, A. F. (2005). Fuzzy regression models. Penn State University, 6, 12.

A Fuzzy Inference Method Based on Logistic Regression for Diabetes Diagnosis

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Abstract

Medical diagnosis is one of the most important decision-making problems. Vagueness, linguistic uncertainty, subjectivity, measurement imprecision and natural diversity issues makes the medical diagnosis very complex area. All these uncertainties suggest the use of a fuzzy logic approach to diagnosis. In literature, fuzzy inference systems and logistic regression are widely used techniques in medical diagnosis area. This study focuses on diabetes diagnosis. We select diabetes because it is a very important disease taking into consideration with life quality and relationship with chronic diseases like hearth disease, kidney disease etc. In this paper, a fuzzy inference method based on logistic regression is proposed to cope with all these problems. The proposed approach consists of four phases: (1) deciding the significant inputs and interactions to generate less rules with logistic regression method. (2) Generating IF-THEN rules according to both literature and data (3) Diagnosis of diabetes according to Mamdani-type inference (4) Comparing the results to show the accuracy of the proposed approach. The dataset is Pima Indian Diabetes Dataset from UCI Data Repository to generate the rules and test the estimations.

Keywords: *medical diagnosis, fuzzy logic, logistic regression, fuzzy inference system, diabetes.*

References

- [1] Abadi, D.N.M, Khoban, M.H., Alfi, A., Siahi, M. (2014). Design of Optimal Self-Regulation Mamdani-Type Fuzzy Inference Controller for Type I Diabetes Mellitus, Arab J Sci Eng., 39, 977–986.
- [2] American Diabetes Association. (2009). Diagnosis and Classification of Diabetes Mellitus Diabetes Care., 32 (Suppl 1), 62–67.
- [3] Classification of Blood Pressure- The Seventh Report. Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK9633>.
- [4] Cokluk, O., Sekercioglu, G, Buyukozturk, S. (2014). Sosyal Bilimler Icin Cok Degiskenli Istatistik. Ankara, Pegem Akademi.
- [5] Lamb, J. Diabetes Research Report, Retrieved from <http://mercury.webster>.
- [6] Pima Indians Diabetes Data Set (1990) Retrieved from <https://archive.ics.uci.edu/datasets>
- [7] Prajapati, H., Pal, S.K., Jain, A. (2016). Expert System for Diagnosis of Diabetes: A Review, International Journal of Advances in Engineering & Technology, 9, 532-537.
- [8] Ubeyli, E.D. (2010) Automatic diagnosis of diabetes using adaptive neuro-fuzzy inference systems, Expert Systems, 27 (4), 259-266.
- [9] World Health Organization (2013) Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy.

Fuzzy Linear Regression Model for Estimation of Carbon Emission for Light Duty Vehicles

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Abstract

Greenhouse gas (GHG) emissions mitigation is a high priority issue for most of the countries in the world. Many international organizations try to promote climate change mitigation. Especially European Commission has begun to investigate to develop policies since 2006 targeting a 40% reduction in GHG emissions by 2030. According to the European Commission, light duty vehicles (cars and vans) produce around 15% of the European Union (EU)'s CO₂ emissions. EU legislation sets binding emission targets for new car and van fleets and as the automotive industry works towards meeting these targets; average emissions are falling each year. For this purpose, these international organizations support to all industrial sectors such as road freight sector for improvements in efficiency in order to reduce GHG emissions. Furthermore, automotive industry carries out long-term investments and develops innovative technologies to cut emissions. Regarding the CO₂ emissions for the vehicles, there are different approaches taking into account factors such as fuel consumption, distance, weight of the vehicle, vehicle acceleration, slope of the road and methods such as regression or other type of equations to estimate emissions of vehicles. In the literature, generally a few factors are considered as an emission factor and most of them are related to the road conditions or fuel type of the vehicle. In this study, many different technical specifications such as vehicle of configuration, displacement, weight of the vehicle, transmission type, fuel type and number of gears are considered. Due to the uncertainty and inaccuracy of the measurements, we choose Tanaka's fuzzy linear regression model to estimate carbon emission of light duty vehicles. The proposed model is preparatory study and it will be used as a tool for the future research.

Keywords: Fuzzy linear regression, carbon emissions, light duty vehicle, greenhouse gas emissions

References

- [1] Tanaka, H., Uejima, S., Asai, K. (1982). Linear Regression Analysis with Fuzzy Model. IEEE Transactions on Systems, Man, Cybernetics. Volume (12), 903-907.
- [2] Lai, Y, Hwang, C. (1992) Fuzzy Mathematical Programming: Methods and Applications. Berlin, Germany: Springer-Verlag Berlin Heidelberg.
- [3] Azadeh, A., Khakestani, M., Saberi, M. (2009). A flexible fuzzy regression algorithm for forecasting oil consumption estimation. Energy Policy. Volume (37), 5567-5579.
- [4] Toro, E.M., Escobar, A.H., Granada, M.E. (2016). Literature review on the vehicle routing problem in the green transportation context. Revista Luna Azu'l, Volume (42), 362-387.

A Decision Support System Based on a Fuzzy-Stochastic Mathematical Program for Intermodal Fleet Planning Problems

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Abstract

In this research, a web-based decision support system based on a fuzzy-stochastic mathematical programming model is developed for intermodal fleet management problems of a large-scaled international logistics company. In the proposed model, several sub-problems such as load planning, fleet sizing/composition, fleet allocation, vehicle inventory control, fleet expansion/reduction and empty vehicle repositioning decisions are handled. Since real-life applications in fleet management may contain different types of uncertainties simultaneously such as randomness and fuzziness, a hybrid chance-constrained programming and fuzzy interactive resolution based approach is utilized. In the data component of the proposed decision support system, an object-relational database management system which is named as Oracle was employed. The developed LINGO 15.0 optimization code of the proposed model is run over C# and object-oriented matching was used for providing connection among Oracle database and C# programs. The web-based user interface is designed by using .Net and C# programs on Microsoft Visual Studio. In the model component, transit times and CO2 emission values are also considered in addition to minimize transportation costs. In order to obtain compromise solutions, a weighted additive fuzzy goal programming approach is applied. The computational results have shown that effective and efficient fleet plans can be generated by making use of such a decision support system under different risk-levels.

Keywords: *Web-based decision support systems, Fuzzy mathematical programming, Intermodal fleet planning*

References

- [1] List, G.F., Wood, B., Nozick, L.K., Turnquist, M.A., Jones, D.A., Kjeldgaard, E.A., Lawton, C.R. (2003). Robust optimization for fleet planning under uncertainty. *Transportation Research Part E* 39(3), 209-227.
- [2] Caris, A. Macharis, C. Janssens, G.K. (2013). Decision support in intermodal transport: A new research agenda. *Computers in Industry* 64(2), 105-112.
- [3] Jimenez, M., Arenas, M., Bilbao, A., Rodriguez, M.V. (2007). Linear programming with fuzzy parameters: An interactive method resolution. *European Journal of Operational Research* 177, 1599–1609.
- [4] Milenkovic, M., Bojovic, N. (2013). A fuzzy random model for rail freight car fleet sizing problem. *Transportation Research Part C* 33, 107-133.

Fuzzy Axiomatic Design Methodology for Selection of Routing Alternatives in Intermodal Transportation

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Abstract

In this paper, application of a Fuzzy Axiomatic Design Methodology is presented for selection of the best routing alternatives in an intermodal transportation network. The purpose of this research is to provide a decision aid for intermodal routing operators for evaluation of various transportation routing alternatives in a more complete manner, while considering the economic, environmental, timing, reliability and risk aspects of the problem. The fuzzy axiomatic design methodology is started with the specification of the functional requirements (criteria), design parameters based on the intermodal operators' preferences and the relationship between them to select the best routing alternatives in multiple transportation modes. In order to demonstrate practicality and applicability of fuzzy axiomatic design methodology, a real-life case study on the selection of road, marine and railway transportation routes from Turkey to Europe is also presented for an international logistics company. The results have shown that economic, timing and reliability are specified as the most important criteria while selecting the transportation routes. Additionally, it was also demonstrated that Trieste seaport and Cologne rail station should be the main terminals of the best routes on the transportation network.

Keywords: Multi-criteria decision making, Fuzzy axiomatic design, Intermodal routing problem

References

- [1] Kannan, D., Govindan, K., Rajendran, S. (2015). Fuzzy Axiomatic Design approach based green supplier selection: a case study from Singapore. *Journal of Cleaner Production* 96(1), 194-208.
- [2] Vinodh, S., Kamala, V., Jayakrishna, K. (2015). Application of fuzzy axiomatic design methodology for selection of design alternatives. *Journal of Engineering, Design and Technology* 13(1), 2-22.
- [3] Özel, B., Özyörük, B. (2007). Bulanik aksiyomatik tasarım ile tedarikçi firma seçimi. *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi* 22(3), 415-423.
- [4] Suh, N.P. (2001). *Axiomatic Design—Advances and Applications*, Oxford University Press, New York.
- [5] Wang, Y., Yeo, G.T. (2017). Intermodal route selection for cargo transportation from Korea to Central Asia by adopting Fuzzy Delphi and Fuzzy ELECTRE I methods. *Maritime Policy & Management*, DOI: 10.1080/03088839.2017.1319581.
- [6] Pahlavani P., Delavar, M.R. (2014). Multi-criteria route planning based on a driver's preferences in multi-criteria route selection. *Transportation Research Part C* 40, 14-35.

Fuzzy Logic Control for Pitch and Yaw Angles of a Dual Rotor Helicopter

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Abstract

In this paper, a real-time fuzzy logic controller (FLC) is developed for Pitch and Yaw angles of a dual rotor helicopter system. We used 4 different fuzzy logic PID controllers providing the output voltage reference in an ADC-PWM converter. This control system is divided into two subsystems, which are used for Pitch and Yaw angle controllers (Figure 1). A type1 Mamdani-Style fuzzy logic controller is implemented in each subsystem. The inputs of FLC are position error and rate of errors. Furthermore, integral of errors is applied to minimize the Steady State Error (SSE). The experimental setup system consists of four BLDC motors, two 1024-bit encoders, “GoogolTech GT-800” DSP and driver board. The fuzzy code has been programmed firstly in the MATLAB software, then this program is converted into VC++ code. This code is embedded in DSP system. The ability of a fuzzy controller to reduce adverse effects due to step- and ramp-type disturbances is investigated. Experimental results demonstrate that our trajectory tracking of a helicopter attitude is good and system stability is improved.

Keywords: Helicopter Dual Rotor, FLC, Trajectory Tracking, MATLAB, DSP, BLDC motor

References

- [1] R. Roman, R. Precup, Model-Free Fuzzy Control of Twin Rotor Aerodynamic Systems, IEEE 25th Mediterranean Conference on Control and Automation (MED), July 3-6, 2017, Valletta, Malta
- [2] Chriette, F. Plestan. Nonlinear Modeling and Control of a 3 DOF Helicopter, Proceedings of the ASME 2012 11th Biennial Conference on Engineering Systems Design and Analysis ESDA2012 July 2-4, 2012, Nantes, France.
- [3] A. Cisel, O. Kaynak, Trajectory Tracking of a 2-DOF Helicopter System using Neuro-Fuzzy System with Parameterized Conjunctors (2014), IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM) Besançon, France, July 8-11, 2014.
- [4] D.K. Saroj, I. Kar, T-S Fuzzy Model Based Controller and Observer Design for A Twin Rotor MIMO System. Fuzzy Systems (FUZZ), 2013 IEEE International Conference, 1098-7584.
- [5] T. Hosseinalizade, S.M.J. Hosseini, Design and implementation classical, state feedback and fuzzy controllers on twin rotor system, 2016 IEEE Control, Instrumentation, and Automation (ICCIA), 2016 4th International Conference 978-1-4673-8704-0/

Fuzzy Logic Based Position Control of Triglidge Robot

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Abstract

In this paper, three degrees of freedom triglide parallel robot which is usually used in pick and place operations has been controlled. Triglidge robot has been controlled by using fuzzy logic control method via a program written in Matlab being used dynamic equations with inverse and forward kinematic solutions of the robot. The derivative of error and error has been preferred as the input in the fuzzy logic structure. As the output, the control signal is generated from the fuzzy logic structure. The limit values of the membership functions of the fuzzy logic controller were found by optimization using the genetic algorithm via a program written in the Matlab package program. The controls have been repeated for two different reference points to demonstrate the success of the fuzzy logic controller on the triglide parallel robot. The system responses have been obtained graphically with the controls applied to the triglide parallel robot and the results have been examined. As a result, it is obviously seen that the system has reached the desired reference values approximately in 0.2 seconds with the fuzzy logic controller.

Keywords: Dynamics, Genetic algorithm, Kinematics, Fuzzy Logic Control, Triglidge.

References

- [1] Sciavicco L, Siciliano B. Modeling and Control of Robot Manipulator. 2nd ed. London: Springer; 2000.
- [2] Merlet JP. Parallel Robots. 2nd ed. The Netherlands: Springer, 2006, p. 75-76.
- [3] Merlet JP. On the infinitesimal motion of parallel manipulators in singular configurations. In: Proceedings of IEEE International Conference on Robotics and Automation, Nice, France, 1992.
- [4] Bi ZM, Lang SYT. Joint workspace of parallel kinematic machines. Robotics and Computer Integrated Manufacturing 2009; 25:57-63.
- [5] Merlet JP. Determination of the orientation workspace of parallel manipulators. Journal of Intelligent and Robotic Systems 1995; 13: 143–160.
- [6] Mustafa M, Misuari R, Daniyal H. Forward kinematics of 3 degrees of freedom delta robot. In: The 5th Student Conference on Research and Development, Malasia, 11-12 December 2007.
- [7] Merlet JP. Parallel Robots. 2nd ed. The Netherlands: Springer, 2006, p. 31-34.
- [8] Aydın M, Alli H. Üç serbestlik dereceli Triglidge paralel robotun ters ve düz kinematik çözümlerinin analitik olarak elde edilmesi. TOK2012, Nigde, Turkey, 2012.
- [9] Aydın M, Alli H. The Obtaining of Dynamic Equations for Three Degrees of Freedom Parallel Robot. In: Proc. of the International Conference on Advances in Mechanical and Automation Engineering - MAE 2016, Roma, Italy, 2016.

Extension of Full Type-2 Fuzzy Clustering Using α -Planes

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Abstract

Fuzzy clustering is one of the well-known technique to recognize patterns in any given data set. There has been an increased research interest in developing Type-2 fuzzy clustering algorithm to manage uncertainty in its Type-1 version. In recent years, many researchers have studied on enhancing interval Type-2 fuzzy clustering algorithm due to reducing the computational complexity of using Type-2 fuzzy sets. Turksen (2013) has proposed Full Type-2 fuzzy c-means (FT2FCM) as a new foundation approach for fuzzy system modelling. The distribution of secondary memberships can be obtained using this proposed approach. Furthermore, FT2FCM has less computational complexity than it is expected. The purpose of this study is to manage uncertainty in fuzzifier m in FT2FCM. Therefore, the extension of FT2FCM is proposed using α -planes representation. Several experimental results and comparisons are given to show the achievement of this proposed algorithm.

Keywords: Full Type-2, Fuzzy clustering, α -Planes, Uncertainty

References

- [1] Bezdek, J.C. (1981). Pattern recognition with fuzzy objective function algorithms. New York: Plenum Press.
- [2] Guh, Y.Y., Yang, M.S., Po, R.W., Lee, E.S. (2009). Interval-valued fuzzy relation-based clustering with its application to performance evaluation. Comput. Math. Appl., 57, 841–849.
- [3] Hwang, C., Rhee, F.C.H. (2007). Uncertain fuzzy clustering: interval type-2 fuzzy approach to c-means. IEEE Trans. Fuzzy Syst., 15, 107–120.
- [4] Linda, O., Manic, M. (2012). General type-2 fuzzy c-means algorithm for uncertain fuzzy clustering. IEEE Trans. Fuzzy Syst., 20, 883–897.
- [5] Türksen, I.B. (2002). Type-2 representation and reasoning for CWW. Fuzzy Sets and Systems, 127, 17–36.
- [6] Turksen, I.B. (2013). Full Type 2...Full Type n Fuzzy System Models. the 13th Annual Conference of the European Network for Business and Industrial Statistics (ENBIS-13), Ankara (15-19 September).
- [7] Wu, D., Mendel, J. (2007). Uncertainty measures for interval type-2 fuzzy sets. Information Sciences, 177, 5378–5393.
- [8] Zadeh, L.A. (1975). The concept of a linguistic variable and its applications in approximate reasoning (I). Information Sciences, 8, 199–249.

A Fuzzy Automatic New Topic Identification System: FANTIS

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Abstract

Since search engines became the most important information retrieval tools for Internet users, they have been on the focus of some of the past and ongoing research activities. Some of these studies are related to the personalization of search engines to lead to more efficient search sessions for the users. One specific problem researchers have been studying over the past years in that area is automatically identifying topic changes during a single search session, namely automatic new topic identification. The purpose of this study is to present a Fuzzy Automatic New Topic Identification System (FANTIS) to estimate topic changes in search engine transaction logs. Sample datasets of two search engines are used for the illustration of the approach. We propose a two-input, one-output and three-rule fuzzy system using the general topic continuation and shift distribution information in the datasets to be used for automatic new topic identification. We assume Gaussian type of membership functions for the two inputs and a triangular-shaped membership function for the output. First input of FANTIS is the time interval between two consecutive queries whereas the second input, search pattern, shows some textual pattern relationships between the corresponding query pairs. The first input, as its name implies, represents the time difference between the queries. We utilize an algorithm (search pattern identification algorithm) to identify the search pattern input. Finally, the output of the system represents topic continuation-shift estimations for automatic new topic identification. Our findings show that FANTIS can successfully be used as an automatic new topic identification tool. We note that the proposed approach produces satisfactory results and also stands out as a flexible and simple approach for automatic new topic identification. The proposed approach contributes to the solution of the automatic new topic identification, one of the important problems in information retrieval to be solved for achieving the goal of personalized search engines to yield more efficient search sessions.

Keywords: *Automatic new topic identification, Information retrieval, Query clustering, Fuzzy logic*

References

- [1] Cavdur, F. (2014). FANTIS: A Fuzzy Automatic New Topic Identification System. *International Journal of Fuzzy Systems*, 16(1).
- [2] Spink, A., Ozmutlu, H. C. (2002). Characteristics of question format web queries: An exploratory study. *Information processing & management*, 38(4), 453-471.

A Fuzzy Approach to Determine the Quality of Automatic Summaries

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Abstract

Text summarization aims to generate brief version of document which substitutes the source document as much as possible for both readers and the information retrieval tasks. To measure this substitution and determine the quality of automatic summaries, a common approach is comparing the automatically generated summary with human-made abstracts. However, before performing automatic summary evaluation, it should be clarified how similar a human-made abstract is to the source document. In this study, summary evaluation methods are examined and a common task-based evaluation method, document clustering, is performed to evaluate human-made abstracts. Here, the evaluation aims to resolve whether the summary is effective in covering whatever information in the document is necessary to correctly cluster the document. However, because of the vagueness in the nature of text documents, the traditional clustering algorithms may not extract the desired clusters correctly that reduces the accuracy of the summary qualities. Therefore, in this study, fuzzy clustering is reconceived as a more sufficient summary evaluation method compared with standard clustering based methods. First, a corpus of documents together with abstracts, CL-SciSumm 2016 [1] (86 articles containing 10 articles and their citances), is utilized. Three type of feature vector is extracted which are document-term matrix by (i) binary values according to the existence of the term in the document, (ii) TF (term frequency) values, and (iii) TF-IDF (TF-inverse document frequency) values. K-means and Fuzzy c-means (FCM) are performed on source documents and abstracts in the experiments repeated 5 times. The expectation of these clustering approaches is determining 10 clusters, as so each reference article is clustered with their citing articles. The performance is evaluated by homogeneity, completeness and v-measure (harmonic average of homogeneity and completeness). Once the K-means and FCM approaches are applied on source documents represented by binomial feature vector, the average v-measures are 0.286 for K-means and 0.409 for FCM. Regarding the clustering of abstracts, these values are 0.281 and 0.399 respectively. Considering the TF feature vector, 0.293 (for K-means) and 0.302 (for FCM) v-measures are produced in source document clustering; 0.278 and 0.489 v-measure values are provided by abstract clustering respectively. The best clustering performance is achieved by TF-IDF feature vector. Here 0.635 (for K-means) and 0.615 (for FCM) v-measures are produced in source document clustering; 0.503 and 0.445 v-measures are provided by abstract clustering respectively. Overall, the results show that FCM reflects the substitution relation between human-made abstracts and source documents precisely, and mostly outperforms the k-means.

Keywords: *Fuzzy clustering, text summarization, summary evaluation*

References

- [1] Jaidka, K., Chandrasekaran, M.K., Rustagi, S., and Kan, M.Y., Overview of the CL-SciSumm 2016 Shared Task. Joint Workshop on Bibliometric-enhanced Information Retrieval and NLP for Digital Libraries. 2016. pp. 93–102.

A Fuzzy Marketing Strategy Benchmarking Analysis in Service Sector

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Abstract

In recent years, economic instability and difficulties made entrepreneurs aim on service sector, which they can make profit in a shorter period with fewer costs. Airline transportation market is one of the favorite activity areas of service sector, and is one of the most important key factors that developed the World economy by vitalizing the international economic activities and exchanges among and between countries. Marketing strategies and activities come into prominence, when companies see the rough and merciless competitive nature of the airline market. In this study, a benchmarking of airline companies in terms of marketing strategies emerging during service consumption is executed. Benchmarking problem is a multi-criteria decision making (MCDM) problem which involves both tangible and intangible evaluation criteria, and this situation leads to the requirement of employment of fuzzy logic in the solution approach of the problem [1, 2]. In this point of view, fuzzy PROMETHEE method is employed to handle the evaluation and benchmarking process. F-PROMETHEE is a robust and reliable MCDM methodology, which is used when linguistic variables exist in the input data and decision makers want to evaluate the alternatives under each criterion differently. The original PROMETHEE method is a MCDM technique developed by Brans [3] and the combination of fuzzy set theory and the PROMETHEE method was first proposed by Le Teno and Mareschal [4]. To indicate the agility, usefulness and accuracy of the proposed approach, a real world application is made with five airline transportation companies from Turkey domestic market. Results attained implied the validity of our proposed fuzzy approach.

Keywords: Fuzzy PROMETHEE, Marketing strategy, Benchmarking, Airline market

References

- [1] Yılmaz, B., Dağdeviren, M. (2011). A combined approach for equipment selection: F-PROMETHEE method and zero one programming, *Expert Systems with Applications*, 38, 11641 – 11650.
- [2] Yılmaz Kaya, B., Dağdeviren, M. (2016). Selecting Occupational Safety Equipment by MCDM Approach Considering Universal Design Principles, Human Factors and Ergonomics in Manufacturing & Service Industries, 26 (2), 224-242.
- [3] Brans, J. P. (1982). L'ingénierie de la décision; Elaboration d'instruments d'aide à la décision. La méthode PROMETHEE". L'aide à la décision: Nature, Instruments et Perspectives d'Avenir, 183–213.
- [4] Le Teno, J. F., Mareschal, B. (1998), "An interval version of PROMETHEE for the comparison of building products' design with ill-defined data on environmental quality", *European Journal of Operational Research*, Vol. 109, pp. 522–529.

A Fuzzy Graph Based Approach for Delivery by Drone in Smart Cities

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Abstract

Package delivery with the drone, considered a utopian idea when thought of years ago, is now seen as an investment that will provide an economic gain. The main difficulty here is the route intensity and the size of the package size. Nowadays, it is an important negativity that the drones can carry only one package and the necessity of charging afterwards. For this reason, it is important for the drone to make a lot of deliveries as little as possible at low cost in terms of low cost. In this study, we propose a punctuation approach based on a graph model that uses fuzzy logic for delivery with drone, especially in the current conditions of smart city applications. The main purpose of the work is to develop a suitable approach to integrate the delivery application with the drone, which is increasingly used with smart city applications, apart from a typical traveling salesman problem. In the scope of the study, modeling of the route taken as an entrance in order to make deliveries in a short distance with drone is done by constructing this graph using a fuzzy system and then finding the optimum path and integrating this solution with smart city. As is known, a graph is a structure that consists of nodes and distances that represent the distance or causal effects between nodes. In particular, the graph structures used for solving many engineering problems become more effective with the use of fuzzy logic in order to model some uncertainties. Designing and implementing fuzzy logic-based graphs for drone use in delivery problems with multiple delivery points, especially in smart city applications, is one of the main contributors to this work. To verify the resolution of the delivery problem with the proposed fuzzy graph structure and the drone using this structure, simulation results were given in the study. It is clear that the approach proposed in the simulations in which comparative results are obtained with classical solutions is an effective and feasible solution.

Keywords: Fuzzy graph, Smart city, Delivery by drone, Fuzzy system.

References

- [1] Dalibor Krleža, Kresimir Fertilj, (2016), Graph Matching using Hierarchical Fuzzy Graph Neural Networks, IEEE Transactions on Fuzzy Systems.
- [2] Yu. A. Korablev, (2017), Diagnostic Models Based on Fuzzy Graphs, IEEE International Conference on Soft Computing and Measurements (SCM), 228-230.
- [3] DHL Trend Research, (2014), Unmanned Aerial Vehicles in Logistics, DHL Customer Solutions & Innovation.
- [4] Andres Monzon, (2015), Smart Cities Concept and Challenges: Bases for the Assessment of Smart City Projects, Springer International Publishing, Switzerland.

A Fuzzy Analysis Approach for User Continuity in Mobile Application Lifecycle Management

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Abstract

Many mobile applications will be developed to facilitate human life and reduce financial value, and these mobile applications will provide platform-based mobile application stores at the present time. Mobile applications are categorized and made available for use in mobile application stores. Mobile life cycle begins when users download the targeted mobile application from the mobile application store. Mobile life cycle; It can be an improved application and differentiation to provide end-to-end success and continuation of mobile applications. The mobile application installations, in turn, enable the accumulation to be made. The data accumulates according to the format of people's mobile application usage and can be used for innovation, activity and improvement.

In this study, we present a data analysis method that uses fuzzy logic to provide user continuity, beginning with user acquisition, which is the first step to successfully complete the mobile application life cycle. The main aims of working within this scope are; Analysis of mobile application lifecycle components and analysis of mobile application life cycle components, analysis of mobile application life cycle components through real applications, research of data analysis techniques and development of techniques used in mobile applications, development of fuzzy based data analysis methods.

Keywords: *Lifecycle management, Mobile application, User continuity, Fuzzy system.*

References

- [1] L.A. Zadeh (1965, Pages 338-353). "Fuzzy Sets, Information and Control",
- [2] Kawser Wazed Nafi, Tonny Shekha, Md. Amjad Hossain, M.M.A Hashem (2012). "An Advanced Certain Trust Model Using Fuzzy Logic and Probabilistic Logic theory", International Journal of Advanced Computer Science and Applications, Bangladesh.
- [3] TJ Ross (2005). "Fuzzy Logic with engineering applications", Wiley Online Library.
- [4] Y. Lin, W.J. Zhang, C. Wu, G. Yang, J. Dy (2009, Pp. 455-463). "A fuzzy logics clustering approach to computing human attention allocation using eyegaze movement cue", International Journal of Human-Computer Studies.
- [5] Fuggetta, G. P. Picco, and G. Vigna (1998 Pp. 342–361). "Understanding code mobility," IEEE Transactions on Software Engineering.
- [6] Kiritzis D., Bufardi A., Xirouchakis P. (2003, Pp. 189–202) "Research issues on product lifecycle management and information tracking using smart embedded systems" Advanced Engineering Informatics.
- [7] Clift R., Doig A., Finnveden G. (2000, Pp. 279-287). "The Application of Life Cycle Assessment to Integrated Solid Waste Management", Process Safety and Environmental Protection.

Development of Vision Based Multiple Anomaly Detection Algorithm Using Fuzzy System for Moving Objects on Conveyor

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Abstract

Nowadays, the use of vision-based control systems, which monitor deficiency of fast-moving objects on a mass-production line, products' features or only product's situation, has become widespread. In the control process of products on the high-speed conveyor, a fast inspection process is a substantially sensitive and significant issue. During an inspection process, even a simple mistake will lead to the emergence of serious problems for users of the products. These systems that are especially used to rapidly control products on the conveyor can also perform various functions such as detecting defects on products, counting the number of products or measuring physical dimensions of products. In this paper, we have studied images from either multiple cameras or single camera for moving objects on conveyors at companies made mass production. To detect more anomalies with various features using a fuzzy rule based system on images obtained through using frame grabber cards, the development of a real-time computing algorithm has been aimed. For the proposed algorithm, computer simulations have performed algorithms primarily for fast image processing. Then, the studies that have been done with Frame Grabber card, which supports higher programming platforms, have been integrated and a fast and system adapted algorithm has been presented. Consequently, results on experimental data verify that the proposed algorithm achieves a significant performance and accuracy. This study has been supported by Turkey Ministry of Science, Industry and Technology (SANTEZ Programme) under Project No: 0743.STZ.2014 (TUBITAK Grant No:112D021).

Keywords: *Vision inspection, Fuzzy system, Conveyor, Anomaly detection, Computer vision.*

References

- [1] H. Zhang, and D. Li, (2014), "Applications of computer vision techniques to cotton foreign matter inspection: A review", *Computers and Electronics in Agriculture*, vol. 109 pp. 59-70.
- [2] Y. Yang, C. Miao, X. Li, and X. Mei, (2014), "On-line conveyor belts inspection based on machine vision", *Optik*, vol. 125, pp. 5803-5807.
- [3] J. Killing, (2007), "Design and Development of an Intelligent Neuro-Fuzzy System for Automated Visual Inspection", the Degree of Master of Science, Queen's University.
- [4] Yazdi, A. S. Prabuwno and E. Golkar, (2011), "Feature extraction algorithm for fill level and cap inspection in bottling machine", *International Conference on Pattern Analysis and Intelligent Robotics (ICPAIR)*, vol. 1, pp. 47-52.

A Fuzzy Based Brain-Computer Interaction Approach Using Feature Extraction for Personal Identification and Authentication

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Abstract

As is known, the number of the researches that contains computer-based control applications which is conducted by measuring brain signals are increasing in recent years. Especially an efficient information retrieval through the measured brain signals in brain-computer interaction is extremely important. However, the brain signals of each individual vary in a certain way. In this article, a new brain-computer interaction which uses multi-purpose feature inference technique for personal identification and verification is presented. In the recommended approach, the brain signals that has been obtained from different individuals experimentally are analyzed and categorized using fuzzy logic. For this signals which are too complicated and quite hard to distinguish to be categorized efficiently, signals are optimized through multi-purpose optimization techniques and features are inferenced and according to the signals obtained, the personal identification is conducted. In order to prove the reliability of the recommended approach, all the data has been obtained from ten different persons in different conditions using a measuring device (Emotiv Epoc+ EEG Headset) and this data has been processed with the method that has been developed and it's been observed that the recommended approach can conduct personal identification and verification accurately. The main contribution of this article which conducted real-timely and comparative results are given in is developing of a fuzzy based new method which can apply sortation for personal identification using EEG signals. This method which makes it possible to conduct identification process shortly after calibration of the brain signal measurement device can also be used in security applications.

Keywords: Brain-computer interaction, Personal identification, Feature extraction, Fuzzy system.

References

- [1] Mohammed H. Alomari, Aya Samaha, Khaled AlKamha, (2013), Automated Classification of L/R Hand Movement EEG Signals using Advanced Feature Extraction and Machine Learning, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 4, No. 6.
- [2] Erik Andreas Larsen, (2011), Classification of EEG Signals in a Brain-Computer Interface System, Master of Science in Computer Science, Norwegian University of Science and Technology, Department of Computer and Information Science.
- [3] Mohammad Reza Khalghani, Mohammad Hassan Khooban, Esmail Mahboubi-Moghaddam, Navid Vafamand, Mohammad Goodarzi, (2016), A self-turning load frequency control strategy for microgrids Human brain emotional learning, International Journal of Electrical Power & Energy Systems, 75:311–319.

A Fuzzy Based Matching Algorithm for Optimized Keypoints in Image Mosaicing

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Abstract

Image mosaicing, which aim to combine images taken from multiple cameras or taken in different times according to the common scenes they contain, have a wide range of applications from military applications to medical applications [1]. Image mosaicing can be used to get high-resolution photos from low-resolution photos as well as to get panoramic images or remove moving objects on a video. So, increasing the quality of the image mosaicing is necessary for many areas especially for mission-critical applications. Fuzzy systems are used in image processing applications [2]. In this study, a method based on fuzzy systems is proposed to enhance the image mosaicing performance. Basically, feature based image mosaicing approach consists of taking images, detecting key points, extracting features of key points, matching key points, eliminating mismatches and estimating homography, warping and blending steps [3]. Estimation of homography, which is the matrix used for warping image, is the most important step which determine the quality of mosaicked image. This estimate is realized by the help of matched key points. So, the correctness of matched points is an important factor for mosaicked image quality. Second nearest neighbor distance rate (SNN) is used for preventing ambiguous matches and reducing mismatches [4]. It has different optimum values for each problem, depending on the details in the images to be mosaicked, although current applications use it as constant. We aim to find the optimal second nearest neighbor distance value with fuzzy logic. For this purpose, the effect of different SNN values are investigated, and fuzzy system is created to find its optimal value. This study is done by using DOG, SIFT, RANSAC algorithms in MATLAB environment [5]. Experimental results are obtained and the effectiveness of the proposed method is shown with the comparative results.

Keywords: *Image processing, Image mosaicing, Fuzzy system, Optimization.*

References

- [1] Laraqui, et al. (2017). Image mosaicing using voronoi diagram. *Multimedia Tools and Applications*, 76(6), pp. 8803-8829.
- [2] E. E. Kerre, M. Nachtgeael (2013). Fuzzy techniques in image processing. 52, *Physica*.
- [3] M. D. Kokate, V. A. Wankhede, R. S. Patil (2017). Survey: Image Mosaicing based on Feature Extraction. *International Journal of Computer Applications*, 165(1).
- [4] H. Yetis, M. Karakose (2016). Adaptive Vision Based Condition Monitoring and Fault Detection Method for Multi Robots at Production Lines in Industrial Systems. *International Journal of Applied Mathematics Electronics and Comp.*, pp. 271-276.
- [5] G. Kaur, P. Agrawal (2016). Optimisation of Image Fusion using Feature Matching Based on SIFT and RANSAC. *Indian Journal of Sci. and Technology*. 9(47), pp. 1-7.

A Risk Assessment Model Modified for Small Scale Construction Sites: A Convenient Fuzzy Approach

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Abstract

Occupational health and safety problems commonly occur in the construction industry. Based on the TRNC labour office statistics, construction industry ranks the highest in occupational accidents with an average of 45 annually reported accidents in the past 5 years. Out of 45, 3.1% of accidents are fatal. When compared with other industries construction industry includes many activities within different work trades causing it to have more risk. The aim of this study is to modify a fuzzy risk assessment model to help minimize accident risk specifically for small scale construction work. The construction accidents reported between years 2008 and 2013 are analysed and categorised as: mechanism of the accident, type of injury and injured body location. The most common accident type reported is falling from height (42.9%). The body part injured most is hand/finger (38.1%) and fracture is the most common injury type (50%). Even though statistics gives us an idea about the current situation a fuzzy approach can be used at construction sites to deal with the uncertainties and to achieve better results related with the project risk level. The model is applied as a case study where hazard assessment was done by using fuzzy set theory and consistent fuzzy preference relations approach (CFPR). This method has been developed by Herrera-Viedma et al (2004) and is supported by the work of Patel et al (2016). Different from previous studies, in this study the work trades and their appropriate attributes were determined from the labour office accident statistics. A pairwise comparison matrix was prepared containing the work trades and their attributes. The expert evaluation of pairwise comparison of work trade hazards was included by administering a face-to-face interview with the civil engineers responsible from the projects. As a result the hazard index for every work trade has been clearly identified and ranked. The modified method is easy to apply by a safety professional or anybody responsible from safety in the company and will have an impact towards a safer work environment.

Keywords: Risk assessment, Construction hazards, Occupational safety, Consistent fuzzy preference relations (CFPR)

References

- [1] Herrera-Viedma, E., Herrera, F., Chiclana, F., & Luque, M. (2004). Some issues on consistency of fuzzy preference relations. *European journal of operational research*, 154(1), 98-109.
- [2] Patel, D. A., Kikani, K. D., & Jha, K. N. (2016). Hazard Assessment Using Consistent Fuzzy Preference Relations Approach. *Journal of Construction Engineering and Management*, 142(12), 04016067.

A Case Study on Fuzzy Risk Assessment of a Warehouse Acceptance Process Based on Risk Matrix Technique

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Abstract

Risk assessment is a comprehensive study to identify and to analyze the dangers and risks that may exist in the workplace or that may arise from outside and ultimately to implement preventive-corrective measures. This study presents a fuzzy risk assessment based on decision matrix having three parameters as the occurrence probability of a danger, the frequency of a danger and the severity of a danger. In the first part of the study, fuzzy risk degrees of risk sources are computed considering these three parameters. The fuzzy decision making trial and evaluation laboratory (F-DEMATEL) method, which is one of the multi criteria decision making methods, is proposed to reveal the priority ranking of risk factors. In the second part of the study, after determining preventive-corrective measures for each risk factor, these measures are ranked by using fuzzy multi attributive border approximation area comparison (F-MABAC) method. This fuzzy risk assessment approach is utilized in the warehouse acceptance process of the tractor production firm.

Keywords: *Fuzzy logic, Fuzzy DEMATEL, Fuzzy MABAC, Risk assessment.*

References

- [1] Gul, M., Guneri, A. F. (2016). A fuzzy multi criteria risk assessment based on decision matrix technique: a case study for aluminum industry. *Journal of Loss Prevention in the Process Industries*, 40, 89-100.
- [2] Yılmaz N., Şenol M.B. (2017) İş sağlığı ve güvenliği risk değerlendirme süreci için bulanık çok kriterli bir model ve uygulaması. *Journal of the Faculty of Engineering and Architecture of Gazi University* 32:1, 77-87.
- [3] Mangla, S. K., Kumar, P., Barua, M. K. (2016). A fuzzy DEMATEL-based approach for evaluation of risks in green initiatives in supply chain. *International Journal of Logistics Systems and Management*, 24(2), 226-243.
- [4] Gul, M., Ak, M. F., Guneri, A. F. (2017). Occupational health and safety risk assessment in hospitals: A case study using two-stage fuzzy multi-criteria approach. *Human and Ecological Risk Assessment: An International Journal*, 23(2), 187-202.
- [5] Debnath, J., & Biswas, A. (2018). Assessment of Occupational Risks in Construction Sites Using Interval Type-2 Fuzzy Analytic Hierarchy Process. In *Industry Interactive Innovations in Science, Engineering and Technology* (pp. 283-297). Springer, Singapore.

Fuzzy Extension of Rapid Entire Body Assessment Method: Application of Hesitant Fuzzy REBA

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Abstract

With the increasing awareness of the concept of occupational health and safety issues, it has become important that ergonomic risk assessments that carried out in companies and the measures to be taken after these assessments are reasonable, logical and sustainable. At this point, when the limited number of resources in the literature are examined, it is inferred that current ergonomic risk assessment methods combine with fuzzy perspective in order to reach more accurate results of these assessments. Generally, in ergonomic risk assessment methods, the subjective evaluation of the experts who perform the assessment is taken into account and it is possible to obtain more accurate results according to the seniority level of experts. However; if the experts do not have sufficient experience or if the expert hesitates in determining the angle and other characteristics of the work position to be assessed, in this case; it is inevitable that researchers need a number of new regulations to solve this problem. In this study, it is aimed to find a solution to these problems with the new method proposed. A new approach has been developed, integrating the Hesitant Fuzzy Linguistic Term Set, which is fairly novel scale in the literature, and its calculation steps with the Rapid Entire Body Assessment (REBA) method thus a new perspective has been introduced to the REBA method. A fuzzy extension which allows both evaluations of a position by more than one specialist and more accurate results in cases where the evaluators hesitate has been applied to the REBA method. A real work application has been carried out in a SME operating in Ankara to clearly express the proposed new method.

Keywords: REBA, Hesitant Fuzzy Term Set, Ergonomic Risk Evaluation

References

- [1] Can, G.F., Atalay, K.D., Eraslan, E. (2015). Çalışma Duruşlarının Bulanık Ortamda Analizi ve Ergonomik İş İstasyonu Tasarım Önerileri. Journal of the Faculty of Engineering and Architecture of Gazi University, 30(3), 451.-460.
- [2] Yavuz, M., Öztayşi, B., Onar, S.Ç., Kahraman C. (2015). Multi-criteria evaluation of alternative-fuel vehicles via a hierarchical hesitant fuzzy linguistic model. Expert Systems with Applications, 42, 2835.-2848.
- [3] Hignett, S., McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). Applied Ergonomics, 31, 201.-205.

Motion Control of Mobile Robots Using Fuzzy Controller

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Abstract

In this paper, a motion control based on fuzzy logic is designed in order that mobile robots might turn more flexible and smoothly while moving to an unknown environment. Fuzzy logic control is suited for controlling a mobile robot because of being able to make inferences even under uncertainty. Fuzzy logic control is implemented by a series of rules which are created by knowledge of expert. The fuzzy rules in this paper is generated for mobile robots in order to avoid obstacles, to turn as soft without damaging and to do not touch the walls. According to obtained simulation results, it is observed that motion control of mobile robot has been achieved by fuzzy logic control.

Keywords: *fuzzy logic; fuzzy logic controller; mobile robot; simulation; motion control*

References

- [1] Sang. S., Wu. H., Zhao J., An Q. "Fuzzy Logic Control for Wheeled Mobile Robots", Sixth International Conference on Fuzzy Systems and Knowledge Discovery, 2009
- [2] Siba M.S., Waladin K. S. and Farah S.K, "A Rule-Based System for Trajectory Planning of an Indoor Mobile Robot", 7th International Multi-Conference on Systems, Signals and Devices, 2010
- [3] Raguraman S.M., Tamilselvi D. And Shivakumar N., "Mobile Robot Navigation Using Fuzzy Logic Controller", International Conference On Control Automation Communication and Energy Conservation, 2009
- [4] Gaonkar P.K., DelSorba A and Rattan K.S, "An Intelligent Robot System using Fuzzy Logic", 48th Midwest Symposium, 2005
- [5] Zadeh L.A., "Fuzzy Sets", Information and Control, vol 8 pp 338-353, 1965
- [6] Dupre M. And Yang S. X. "Two-Stage Fuzzy Logic-Based Controller for Mobile Robot Navigation", International Conference on Mechatronics and Automation, 2006

Susceptible-Infected-Recovered (SIR) Epidemic Model with a Fuzzy Transmission Parameter

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Abstract

In the modeling of real world phenomena, generally some of the information is uncertain. Fuzzy logic is a natural way to model real world events for such situations. In 1965, fuzzy set theory was introduced by L. Zadeh as an extension of crisp sets. Existing crisp set theory utilizes the characteristic functions, as defined by two valued logic, it can only take values of zero and one. In fuzzy set theory, membership function (a function $\mu: X \rightarrow [0,1]$) can take any values in closed unit interval. Besides the study of fuzzy differential equations (FDEs) establishes a suitable setting for mathematical modelling of a real world event in which there is uncertainty and vagueness. Furthermore, differential equations have an important role in the embodiment of numerous biological events and analysis of their circumstances. The outbreak and spread of diseases has questioned and studied for many years. A simple deterministic model predicting the behavior of epidemic outbreaks was formulated by A.G. McKendrick and W.O. Kermack in 1927. In their mathematical epidemic model, called the Susceptible-Infected-Recovered (SIR) model to describe the speed of disease. Many differential equations cannot be solved by analytical methods, it is important to consider what qualitative information can be obtained about their solutions without actually solving the equations. In this study, we will be examining fuzzy initial value SIR epidemic model and obtain graphical solutions for the problem under consideration.

Keywords: Fuzzy Number, Fuzzy initial values, Susceptible-Infected-Recovered (SIR) model

References

- [1] Barnabas, B. (2013). Mathematics of Fuzzy Sets and Fuzzy Logic. Springer.
- [2] Harko, T., Lobo, F. S., & Mak, M. K. (2014). Exact analytical solutions of the Susceptible-Infected-Recovered (SIR) epidemic model and of the SIR model with equal death and birth rates. Applied Mathematics and Computation, 236, 184-194.
- [3] Lee, K. H. (2006). First course on fuzzy theory and applications (Vol. 27). Springer Science & Business Media.
- [4] Linda, J. A. (2007). An introduction to mathematical biology.
- [5] Stefanini, L. (2008). A generalization of Hukuhara difference for interval and fuzzy arithmetic. Soft Methods for Handling Variability and Imprecision, in: Series on Advances in Soft Computing, 48.

A Study on Fuzzy Malthusian Growth Model

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Abstract

Using differential equations is widespread method to model dynamical systems. Moreover, analyzing the solutions and their behavior of ecological models play an important role to understand the phenomenon. Obtaining more realistic models is a crucial issue that scientist work on. The biological parameters which are used in differential equations are not always fixed. In real world, parameters vary due to the changing environmental conditions such as natural disasters, climate and financial changings. Therefore, it is natural to determine the impreciseness of the biological parameters in the behavior of biological models. To add the impreciseness, stochasticity is added in the models. However, the problem of choosing appropriate probability distribution for imprecise parameters arises. So, this makes the problem more complicated. Fuzzy set theory, which is developed by Zadeh [1], is used to overcome to this impreciseness. There are few literature exists in the field of mathematical biology. Bassanazi et al. [2] used fuzzy differential equations to study the stability of fuzzy dynamical system by considering the variables and parameters are uncertain in nature. Barros et al. [2] considered environmental fuzziness of a life expectancy model by taking the parameters is fuzzy in nature. Peixoto et al. [3] presented predator-prey model under fuzziness. Mizukoshi et al. [4] studied the fuzzy initial value problem with parameters and/or initial conditions under fuzziness. Guo et al. [5] studied logistic model and Gompertz model under fuzziness. In this work, we study on fuzzy Malthusian model by using results which are given by Barros et al. Moreover, we introduce interval arithmetic and its application on fuzzy dynamical systems.

Keywords: *Fuzzy initial value problem, fuzzy ecological models, Malthusian growth model*

References

- [1] Zadeh L. A. (1965), Fuzzy Sets, Information and Control, Vol.2, 338-335.
- [2] Barros, L.C., Bassanazi, R.C., Tonelli, P.A. (2000) Fuzzy modeling in population dynamics, Ecol. Model, Vol.128, 27-33.
- [3] Peixoto, M., Barros, L.C., Bassanazi, R.C. (2008) Predator-prey fuzzy model, Ecol. Model, Vol. 214, 39-44.
- [4] Mizukoshi, M.T., Barros, L.C., Bassanazi, R.C. (2009) Stability of fuzzy dynamic systems, Int. J. Uncertainty Fuzziness Knowl. Based Syst., Vol. 17, 69-84.
- [5] Guo, M., Xu, X., Li, R. (2003) Impulsive functional differential inclusions and fuzzy population models, Fuzzy Sets Syst., Vol. 138, 601-615.

A Machine Vision Approach Using Real Time Parallel Computing for Fuzzy Based Inspection Systems with Multiple Cameras

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Abstract

As of recently, the use of machine vision has become increasingly popular, especially in automation-based productions, due to the development of its applications. Advances in high performance imaging systems have greatly contributed to the development of the machine vision, as well as to the inspection systems associated with them. Because computer systems are unable to process the large amount of data generated from advanced camera systems fast enough, users have turned to different solutions, like software-based parallel programming or hardware boards, both of which increase the data processing rate. As a result of the aforementioned reasons, the use of multi-chip video cards for parallel programming has become widespread with their improved performance. In this paper, a fuzzy logic based machine vision approach is proposed, one that operates in real-time with the algorithms and employs multiple cameras to detect errors that might occur in inspection systems and that utilizes parallel image processing techniques. To introduce this proposed approach, images were collected from multiple cameras, an optimized fuzzy system based identification algorithm that utilizes parallel algorithms for fast processing was developed and verification studies were performed. These tasks were conducted by using a C language-based CUDA add-on, which operates on a multi-chip NVIDIA video card, and by developing an application with the help of OpenCV libraries of the C language. Using this developed application, real-time object identification, sensing and error detection tasks were carried out with parallel image processing techniques. The study presents the performance of the proposed fuzzy based machine vision approach by comparing experimental images. This study has been supported by Turkey Ministry of Science, Industry and Technology (SANTEZ Programme) under Project No: 0743.STZ.2014 (TUBITAK Grant No:112D021).

Keywords: *Machine vision, Parallel computing, Vision inspection, Multiple cameras, Fuzzy system.*

References

- [1] W. Zhang, Q. Fu, and Wu, N. J., (2011), "A programmable vision chip based on multiple levels of parallel processors", IEEE Journal of Solid-State Circuits, vol. 46, no: 9, pp. 2132-2147.
- [2] S. Cubero, N. Aleixos, E. Molto, J. G. Sanchiz and J. Blasco, (2011), "Advances in machine vision applications for automatic inspection and quality evaluation of fruits and vegetables", Food and Bioprocess Technology, vol. 4, pp. 487-504.
- [3] Abubakar Muhammad Ashir, (2014), Simulation of Fpga-Based Image Processing System for Quality Control and Palletization Applications, The Electrical-Electronic Engineering Department of Mevlana (Rumi) University.

A Fuzzy Automata Based Approach for Real Time Systems

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Abstract

Today, with the development of electronic technology, real-time systems have become widespread. The real-time concept is to make a job done on time. Time is critical for real-time systems. Real-time systems exist in many areas such as industry, education and health [1,2]. Real-time systems; State monitoring, fault detection, classification and control. In this work, fuzzy automata based approaches are proposed for real time systems. The concept of fuzzy automata is the combination of fuzzy logic and automat. Automata is the method used to model discrete event systems. Discrete events are often referred to as end-automata [3,4]. Although discrete event systems are used to solve many engineering problems, sharp transitions are not possible in some problems. In such cases, fuzzy automata are used. For some problems, fuzzy states and transitions are defined. These states and transitions, which take place in the range $[0,1]$, used instead of sharp transitions, are called fuzzy automata. In a fuzzy automaton, the system may be in more than one state at the same time as different membership grades. There are many studies such as fault diagnosis and status detection with a fuzzy automaton [5]. In this work, a real-time application on the embedded system was developed. In the developed application, a fuzzy automata based method is proposed for state monitoring. The performance of the system has been improved with the fuzzy automata approach. On the real-time systems, the automata and the proposed fuzzy automata approach are compared. In the proposed method, more successful results were obtained by using fuzzy automata based method instead of automata. The advantages of the proposed fuzzy automata approach for real-time condition monitoring are given.

Keywords: Real time systems, Fuzzy systems, Finite state, Fuzzy automata

References

- [1] Luo, H., Krueger, M., Koenings, T., Ding, S. X., Dominic, S., Yang, X. (2017). Real-time optimization of automatic control systems with application to BLDC motor test rig. *IEEE Transactions on Industrial Electronics*, 64(5), pp. 4306-4314.
- [2] Karakose, M., Yaman, O., Aydin, I., Karakose, E. (2016). Real-time condition monitoring approach of pantograph-catenary system using FPGA. *IEEE 14th International Conference on Industrial Informatics (INDIN)*, pp. 481-486.
- [3] Li, L., Qiu, D. (2015). On the State Minimization of Fuzzy Automata. *Fuzzy Systems, IEEE Transactions on*, 23(2), pp. 434-443.
- [4] Deng, W., Qiu, D. (2015). Bifuzzy Discrete Event Systems and Their Supervisory Control Theory". *Fuzzy Systems, IEEE Transactions on*, 23(6), pp. 2107-2121.
- [5] Martinek, P. (2015). Fuzzy multiset finite automata: Determinism, languages, and pumping lemma, In *Fuzzy Systems and Knowledge Discovery (FSKD)*, 2015 12th International Conference on, pp. 60-64.

Fuzzy Logic Inference Approach for Women's Health Monitoring

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Abstract

Women and men are almost equal in the face of diseases. However, women are different in nature. They may become pregnant, carry a second life for 9 months, and may have periods on certain days of each month. This process is specific to women and needs to be prepared both physically and emotionally. It is assumed that periods are repeated by default every 28 days for 3-10 days. However, this situation may vary. Physical properties of the quiche, environmental conditions, living diseases, hormonal changes and the like are influential in this. These and similar reasons may also be related to other diseases. In this case, the most accurate diagnosis can be given by doctors in health institutions. However, the time and cost that it requires, the density that is experienced in health institutions, is disadvantageous. The proposed approach is based on fuzzy logic inference for reducing and helping this requirement. Nowadays, smartphones, which are almost everybody, can collect many anonymous data thanks to the sensors on them. In addition to this, other data to be obtained from the user may be used as an aid in following the periods such as women's specific period, pregnancy. A cloud-based mobile application developed for this purpose uses this user-generated data as input and can perform fuzzy inference personalized to the user. The application is simple to use for every individual who uses a smartphone. Similar studies in the literature have been successfully applied to detect diabetes mellitus, pregnancy abnormalities. Similarly, it has been shown that this approach can be applied by verifying with the simulation data obtained from mobile application.

Keywords: Cloud, Fuzzy Logic, Mobile Health Monitoring

References

- [1] Agrawal, A. T., & Ashtankar, P. S. (2013). Adaptive neuro-fuzzy inference system for health monitoring at home. *International Journal of Advanced Science and Technology*, 55, 89-100.
- [2] Paramita, A., & Mustika, F. A. (2017). Diagnosis of the Diabetes Mellitus disease with Fuzzy Inference System Mamdani. *Journal of Mathematics*, 1(1).
- [3] Sharma, N., & Khullar, V. (2016). Comparative Review of Artificial Neural Network Machine Learning for Diagnosing Aneamia in Pregnant Ladies. *i-Manager's Journal on Information Technology*, 5(4), 33.
- [4] Sharma, N., & Khullar, V. (2016). Comparative Review of Artificial Neural Network Machine Learning for Diagnosing Aneamia in Pregnant Ladies. *i-Manager's Journal on Information Technology*, 5(4), 33.

Prediction of Parkinson's Disease Using Artificial Neural Networks

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Abstract

According to the statistics of Parkinson's Disease Foundation, more than 10 million people worldwide live with Parkinson's disease and the combined direct and indirect cost of Parkinson's is estimated to be nearly \$25 billion per year in the United States alone. The diagnosis of Parkinson's disease depends upon the presence of one or more of the four most common motor symptoms of the disease. In addition, there are other secondary and non-motor symptoms that affect many people. On the other hand, it might be difficult to diagnose the disease since each person with Parkinson's disease experiences symptoms differently. Using artificial intelligence-based approaches might help people in the diagnostic process. In this study, we propose an artificial neural network to diagnose Parkinson's disease in its early stages. We train and test the proposed neural network using a dataset including 195 data points with 23 attributes, corresponding to the 22 inputs and the output of the neural network, obtained from UCI Machine Learning Repository (<https://archive.ics.uci.edu/ml/machine-learning-databases/parkinsons/>) where the inputs define the brain signals of the people with and without disease and the output is given as a 0-1 vector representing the disease status of the corresponding people. The proposed neural network has 22 inputs, a single output. The results imply that the proposed neural network has an important potential to be used in prediction of Parkinson's disease.

Keywords: *Parkinson's disease, Medical diagnosis, Artificial neural networks, Artificial intelligence*

References

- [1] Wu, D., Warwick, K., Ma, Z., Burgess, J. G., Pan, S., & Aziz, T. Z. (2010). Prediction of Parkinson's disease tremor onset using radial basis function neural networks. *Expert Systems with Applications*, 37(4), 2923-2928.
- [2] Geman, O. (2011). A fuzzy expert systems design for diagnosis of Parkinson's disease. In *E-Health and Bioengineering Conference (EHB)*, 2011, 1-4.
- [3] Astrom, F., Koker, R. (2011). A parallel neural network approach to prediction of Parkinson's Disease. *Expert systems with applications*, 38(10), 12470-12474.

Forecasting Seasonal Time Series with Fuzzy Time Series Based on Markov Transition Matrix

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Abstract

Fuzzy time series forecasting methods has got more and more attention in recent years since they have a good capability at forecasting real-world time series which contains uncertainty. There have been various fuzzy time series forecasting methods in the literature. On the other hand, just a few ones have been proposed to forecast seasonal time series. In this study, a seasonal fuzzy time series forecasting method is introduced. Markov transition matrix is utilized to define fuzzy relations between observations in this seasonal forecasting approach. The seasonal fuzzy time series forecasting model is applied to real-world seasonal time series to show the applicability of the model. It is seen from the obtained forecasting results that accurate forecasts are produced for real-world seasonal time series.

Keywords: *Defining fuzzy relations, Forecasting, Fuzzy Time Series, Seasonality, Markov transition matrix.*

References

- [1] Aladag, C.H. (2014), Using Artificial Neural Networks in Fuzzy Time Series Analysis,
- [2] L.A. Zadeh et al. (eds.), Recent Developments and New Directions in Soft Computing, Studies in Fuzziness and Soft Computing 317, pp. 443-451, DOI: 10.1007/978-3-319-06323-2_28, ISBN: 978-3-319-06322-5, Springer International Publishing, Switzerland.
- [3] Chang, P.T., (1997). Fuzzy Seasonality Forecasting. Fuzzy Sets and Systems, 90, 1-10.
- [4] Egrioglu, E., Aladag, Ç.H., Yolcu, U., Basaran, M.A., Uslu, V.R. (2009), A New Hybrid Approach Based on SARIMA and Partial High Order Bivariate Fuzzy Time Series Forecasting Model. Expert System with Applications, 36, 7424-7434.
- [5] K. Huarng (2001-a), Effective lengths of intervals to improve forecasting in fuzzy time series, Fuzzy Sets and Systems, vol. 123, pp. 387-394.
- [6] K. Huarng (2001-b), Heuristic models of fuzzy time series for forecasting, Fuzzy Sets and Systems, vol: 123(3), pp.369-386.
- [7] K. Huarng (2006), H.K. Yu, Ratio-based lengths of intervals to improve fuzzy time series forecasting, IEEE Transactions on Systems, Man, and Cybernetics-PartB: Cybernetics, vol. 36, pp. 328-340.
- [8] H.K. Yu (2005), A refined fuzzy time series model for forecasting, Physica A, vol. 346, pp. 657-681.
- [9] L.A. Zadeh (1965), Fuzzy sets, Information and Control, vol. 8, pp. 338-353.
- [10] Q. Song, B. S. Chissom (1993-a), Fuzzy time series and its models, Fuzzy Sets and Systems, vol. 54, pp. 269-227.

Forecasting with Fuzzy Time Series Models

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Abstract

In the real world, the variability in data collected is one of the fundamental characteristics in any statistical modeling process, and needs to be evaluated efficiently. Many time series are the results of measurement procedures and therefore the obtained values are more or less fuzzy. Also, many economic time series contain values with remarkable uncertainty. The fuzzy set theory developed by Zadeh [1], combined with statistical analysis of time series proposed by Song and Chissom [2,3], has emerged as a practical and efficient alternative among known forecasting tools. This created a hybrid modeling structure, which is capable of significantly reducing the inherent variability of the series of the modeled data. To optimize prediction methods for fuzzy time series, some authors included prediction techniques of artificial intelligence, such as genetic algorithms, fuzzy C-means clustering, artificial neural networks and particle swarm optimization, in their algorithms. In this study, we employ fuzzy time series forecasting method based on particle swarm optimization which is proposed by Aladag et. al [4] to the enrollment data of University of Alabama whose yearly observations are between 1971 and 1992. As a result of the comparison, it is observed that the most accurate forecasts are obtained when the fuzzy time series forecasting method based on particle swarm optimization is used.

Keywords: *Fuzzy time series, Forecasting, Particle swarm optimization, Alabama.*

References

- [1] L.A. Zadeh, Fuzzy Sets, Information and Control 8 (1965) 338–353.
- [2] Q. Song, B.S. Chissom, Fuzzy time series and its models, Fuzzy Sets and Systems
- [3] Q. Song, B.S. Chissom, Forecasting enrollments with fuzzy time series – Part I, Fuzzy Sets and Systems 54 (1993) 1–10.
- [4] C.H. Aladag, E. Egrioglu, U. Yolcu, A.Z. Dalar A new time invariant fuzzy time series forecasting method based on particle swarm optimization, Applied Soft Computing, 12, 2012, 3291-3299.

Forecasting Gold Prices with Fuzzy Time Series

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Abstract

The fuzzy time series was first introduced by Song and Chissom. Since then, it has become a more interesting subject among researchers. Fuzzy time series approaches are generally composing of three main stages such as fuzzification, determination of fuzzy relationships and defuzzification. Artificial intelligence procedures such as artificial neural networks (ANNs) and particle swarm optimization have been successfully used in the fuzzy relationship determination stage of different fuzzy time series forecasting approaches. In the implementation, gold prices (USD/oz.) series is forecasted by fuzzy time series forecasting method based on particle swarm optimization. The results have shown that the predictive accuracy is improved. As a result of the application, it is seen that the method produces accurate forecasting results for the gold prices data.

Keywords: *Fuzzy time series, gold prices, forecasting, particle swarm optimization*

References

- [1] Song, Q., Chissom, B.S., 1993a. Fuzzy time series and its models. *Fuzzy Sets and Systems*, 54, 269-277.
- [2] Song, Q., Chissom, B.S., 1993b. Forecasting enrollments with fuzzy time series- Part I. *Fuzzy Sets and Systems*, 54, 1-10.
- [3] Aladag, C.H., Yolcu, U., Egrioglu, E., 2013. A New Multiplicative Seasonal Neural Network Model Based on Particle Swarm Optimization. *Neural Process Lett*, 37:251–262.

Fuzzy Goodness-of-fit Tests

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Abstract

One of the most important questions in statistics is to obtain information about the population from which the sample is drawn. To find an answer to this question goodness of fit tests are proposed in the literature. In the classical goodness-of-fit tests, the observations of the sample are assumed crisp, but in real life the real data are fuzzy. In this study, one-sample goodness-of-fit tests based on empirical distribution function such as Kolmogorov-Smirnov test, Cramer-von Mises test and Anderson-Darling test are applied on fuzzy data. Finally, some numerical examples are given and the observed fuzzy p-value and fuzzy significance level are compared, in order to accept or reject the null hypothesis of interest.

Keywords: *Anderson-Darling, Cramer-von Mises, fuzzy data, fuzzy set, Kolmogorov-Smirnov.*

References

- [1] Anderson, T. W., Darling, D. A. (1954). A Test of Goodness of Fit. Journal of the American Statistical Association, 49, 765-769.
- [2] Buckley, J. J. (2006). Fuzzy Probability and Statistics. Springer, Germany.
- [3] Cramer, H. (1928). On the Composition of Elementary Errors. Skandinavisk Aktuarietidskrift, 11, 13-74(141-180).
- [4] D'Agostino, R. B., Stephens, M. A. (1986). Goodness-of-fit Techniques. CRC Press, New York.
- [5] Grzegorzewski, P., Szymanowski, H. (2014). Goodness-of-fit tests for fuzzy data. Information Sciences, 288, 374-386.
- [6] Stephens, M. A. (1974). EDF statistics for goodness of fit and some comparisons. Journal of the American Statistical Association, 69, 730-737.

Applications of Fuzzy Logic in Oracle Data Mining Algorithms

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Abstract

This paper focuses on applications of fuzzy techniques for Oracle Data Mining Algorithms. It first gives presentation about the process of analyzing data from different perspectives and summarizing it into some useful information, decomposed into the notion of similarity and the fuzzy machine learning techniques that are applied in the described applications. The main focus, however, is on those concepts of fuzzy logic used in the induction process when dealing with data mining. Indeed, similarity, or more generally comparison measures are used at all levels of the data mining and information retrieval tasks: at the lowest level, they are used for the matching between a query to a database and the elements it contains, for the extraction of relevant data. In the various techniques to generalize particular information contained in this data set, dissimilarity measures are used in the case of inductive learning, similarity measures for case-based reasoning or clustering tasks. Considered the fuzzy learning techniques for a widely applied data mining techniques as clustering, classification, association analysis.

Keywords: Oracle Data Mining, Fuzzy Logic, Cluster Analysis, Classification Analysis, Association analysis

References

- [1] Hullermeier E. Fuzzy sets in machine learning and data mining: Status and prospects. *Fuzzy Sets and Systems*, 156(3):387–406, 2005.
- [2] Hullermeier E. and Y. Yi. In defense of fuzzy association analysis. *IEEE Transactions on Systems, Man, and Cybernetics – Part B: Cybernetics*, 37(4):1039–1043, 2007.
- [3] Rekha M., Swapna M., Role of Fuzzy Logic in Data Mining, *International Journal of Advance Research in Volume 2, Issue 12, December 2014*.
- [4] Indira P. P., Ghosh D.K., A Survey on Different Clustering Algorithms in Data Mining Technique, *International Journal of Modern Engineering Research (IJMER)*, Vol.3, Issue.1, pp-267-274, ISSN: 2249-6645, Jan-Feb. 2013.
- [5] Jafarova H.A., Aliyev R.T., Applying k-means clustering algorithm using Oracle Data Mining to banking data, *Proceeding of Ninth International Conference on Management Science and Engineering Management (ICMSEM 2015)*, Karlsruhe, Germany, July 21-23, 2015.

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