Yıldız Technical University
THE 4TH INTERNATIONAL FUZZY SYSTEMS SYMPOSIUM
FUZZYSS’15
November 5-6
www.fuzzyss.yildiz.edu.tr

BOOK OF ABSTRACTS
FUZZYSS’15
The 4th International Fuzzy Systems Symposium
5-6 November 2015 İstanbul-Turkey
www.fuzzyss.yildiz.edu.tr
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Welcome to FUZZYSS’15!

Dear participants of the FUZZYSS’15 symposium, we are very happy to wish you warmly welcome to The 4th International Fuzzy Systems Symposium Fuzzyss’15 (http://www.fuzzyss.yildiz.edu.tr). The symposium will be the next in the series of the biennial conferences under the same name. The symposiums are organized every two years and the location of the next conference will be decided and announced during this conference.

We hope that you will find this conference fruitful and will also attend future series of FUZZYSS symposiums. The conferences in this series are not too big in size so that it is possible to find colleagues to discuss but still you get a versatile view of the state of the art in fuzzy systems, different approaches, theories and applications. Here you have an excellent opportunity to meet old and make new friends, exchange ideas, receive feedback and get inspired. The main goal of FUZZYSS’15 is to bring together researchers and practitioners from both industry and academia, and to provide them a unique platform for sharing worldwide ideas as well as the recent developments on fuzzy systems.

FUZZYSS’15 Organizing Committee
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CONFERENCE INFO

Conference Venue
The Yıldız campus of Yıldız Technical University is compact and all facilities can be reached on foot. See page xi for a map of campus.
All parallel sessions will take place in the Auditorium Building. The opening session and the keynote talk on Thursday morning will take place in the main saloon of the auditorium building. Parallel sessions on Thursday and Friday will take place also in the Auditorium Building.

Registration
Participants can register between 09.00 and 11:00 on Thursday morning by the Auditorium where the opening session will take place. Registration desk will be open throughout the conference for any assistance you may need, or for late registrations.

Getting Around Istanbul
Istanbul is a very large city with all modes of transportation used to get around. Apart from public buses, trains and trams, the most common means of transportation are taxis, ferry boats, mini buses, and sea buses.

Tickets for public transportation: Istanbul Kart (Istanbul Card, please see below) is in essence an all-round public transportation boarding pass in Istanbul. It is worth getting one if you plan to use (the advantages of) public transportation multiple times during your stay in Istanbul. It’s a contactless or RFID (Radio-frequency identification) card for public transportation fare payment. It has the exact same size as a regular credit card, so it fits perfectly in your wallet. The card is pre-paid in TL (Turkish Lira) and easily rechargeable. In mini busses, which are perhaps unique to Istanbul, the payment is given to the driver in cash.

Where to Get an Istanbul Kart: The easiest way to get the Istanbul Kart is at major transit stops such as the airport, Taksim, Eminönü, Sultanahmet, Beyazıt/Kapalı Çarşı (Grand Bazaar), etc. To buy an Istanbul Kart, you need to pay a non-refundable 10 TL fee (for the actual card and the service), and of course an amount of your choice to load onto the card.

How to Reload the Istanbul Kart: To reload the card, you can either go to newsstands and small shops (look for the phrase Akbil Dolum Noktasi) which offer this service, use self-service special purpose machines at major transit stations. The machines accept notes of 5, 10, 20, and 50 TL and have instructions in multiple languages.

Lunches and Coffee Breaks
Lunches, for Thursday and Friday, will be served in the University refectory. Coffee Breaks will take place inside the Auditorium.

Furthermore, participants can use the university cafeteria located in the Yıldız Campus (see Campus Map on page xi). Payment in all cafes can be done by cash or by credit card.
Gala Dinner

Gala dinner will be at Yıldız Çatı restaurant on Thursday evening at 19:00 (see Campus Map on page xi).

Emergency Contacts

You can contact the organizing committee chair on:
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PROGRAMME OVERVIEW

Thursday, 10:00-12:00 Opening Session and Keynote Speaker

Thursday, 12:00-13:00 Lunch

Thursday, 13:00-14:30, Hall 1
Session: Fuzzy Mathematics-1
Chair: Adil Baykasoğlu
1. Hermite-Hadamard Type Inequality for Preinvex Functions via Sugeno Integrals
   Sercan Turhan, Nurgül Okur Bekar, Selehattin Maden
2. New Operators on Fuzzy Sets: Modified Einstein Operators
   Atınç Yılmaz, Seçkin Ari, Ümit Kocabiçak
3. Approximate solution of fuzzy second order differential equations
   Levent Özçelikman, Mine Aylin Bayrak
4. A New Fuzzy Bayesian Classification Approach
   Necla Kayaalp, Güvenç Arslan
5. Fuzzy Isomorphism Theorems of Idealistic Soft Gamma Rings
   E. Aktaş, B. A. Ersoy, S. Onar, B. Davvaz
6. An extended RQFD method using 2-tuples representation model
   Sawsen Maalej, Habib Chabchoub

Thursday, 13:00-14:30, Hall 2
Session: Fuzzy Multi Criteria Decision Making-1
Chair: Ali Fuat Guneri
   Leila Yahyaie Dizaji, Leila Malekani, Robab Naseri Ghalghachi
2. An Application For Supplier Evaluation Process In Construction Sector Through Fuzzy PROMETHEE Method
   Rahmi Baki
3. Determining Service Attributes of Airline Transportation Industry with Fuzzy QFD Method: An Application in Turkey
   Elif Kılıç Delice, Burcu Yılmaz Kaya, Metin Dağdeviren
   Ebru Turanoglu Bekar, Mehmet Cakmakci, Cengiz Kahraman
5. Technology Competency Evaluation Of Small And Medium-Sized Enterprises in the Turkish Manufacturing Sector By A Multi Criteria Decision Making Approach
   Ufuk Bolukbas, Ali Fuat Guneri
   Güzin Tırkeş, Banu Hatice Gürcüm, Tuğba Altındağ
Thursday, 14:45-16:15, Hall 1
Session: Fuzzy Forecasting-1
Chair: M.Bahar Başkır

1. Preliminary design of aircraft fuselage dimensions for various flight performances by ANFIS subtractive clustering method
   Mohammad H. Sabour, Morteza Mohammadzaheri, Khalil Shamsi, Farhad Ahadi Koloo

2. Retinal Blood Vessel Extraction using image enhancement and modified Fuzzy C-means Clustering
   Zafer Yavuz, Cemal Köse

3. A New Evaluation Approach for Supplier Selection System
   M.Bahar Başkır, İ.Burhan Türkşen, Ömer Saatçioğlu

4. An Analysis of Neural Network-Based Fuzzy Time Series Methods in Turkey
   Özer Özdemir, Sevil Şentürk, Gültekin Atalık

5. Review Study on Fuzzy Time Series and Their Applications in the Last Fifteen Years
   M. Furkan Dodurka, Atakan Sahin, Tufan Kumbasar, Engin Yesil, Sarven Siradag

6. Improving Evaluation System of Program Educational Objectives and Outcomes based on MUDEK Criteria Using Fuzzy Approach
   M.Bahar Başkır, Gonca Yıldırım, Fetih Yıldırım

Thursday, 14:45-16:15, Hall 2
Session: Fuzzy Data Analysis and Risk Assessment
Chair: Elif Kılıç Delice

1. Fuzzy Logic-Based Inquiry Approach on Oracle Database and the Application Of Special Software
   Mustafa Güneş, Seyhun Tuzkan

2. Use of Fuzzy Approaches to Make Predictions on Small Sized Data
   Ahmet Omercioğlu, Yusuf Yılmaz, Ebru Akcapinar Sezer, Hakan Ahmet Nefeslioglu

3. Generalized Fuzzy Entropy Optimization Method for Fuzzy Data Analysis
   Aladdin Shamilov, Sevil Senturk, Nihal Yılmaz

4. Risk assessment model of elevator equipment failure based on fuzzy logic
   İlker Karadağ, Elif Kılıç Delice

5. Fuzzy based human reliability assessment upon cargo discharging operation on-board chemical tanker ship
   Emre Akyuz, Erkan Celik

6. Risk Assessment with Fuzzy 5x5 Matrix Method
   Cansu Dağşuyu, Murat Oturakçı, Yusuf Kuvvetli
Thursday, 16:30-18:00, Hall 1
Session: Fuzzy Control-1
Chair: Kayhan Gulez

1. **Dynamic Performance Analysis of Self-tuning Fuzzy-PID Controller for the Inverted Pendulum System**
   Ahmet Gani, Ö. Fatih Keçecioğlu, Zeynel Baş, Hakan Açıkgoz, Mustafa Şekkeli

2. **Investigation of PID and Self-Tuning Fuzzy PID Controller Achievements for Level and Temperature Control of the Mixing Tank**
   Ahmet Gani, Ö. Fatih Keçecioğlu, Zeynel Baş, Erdal Kılıç, Mustafa Şekkeli

3. **Fuzzy Logic Based Indirect Vector Control of Squirrel Cage Induction Motor**
   Ahmet Nur, Zeki Omaç, Eyyüp Öksüztepe

4. **Intelligent Control of Lotka-Volterra Chaotic System using State Feedbacks and ANFIS**
   Alper Göksu, Uğur Erkin Kocamaz, Yılmaz Uyaroğlu, Harun Taşkin

5. **Automotive airbag fuzzy modelling and control system design by real data collections**
   Morteza Mohammadzaheri, Farhad Ahadi Koloo, Khalil Shamsi, Mohammad H. Sabour, Maryam Ahadi Koloo

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Thursday, 16:30-18:00, Hall 2
Session: Fuzzy Soft Sets
Chair: Banu Pazar Varol

1. **Lowen Functors in Fuzzy Soft Topological Spaces**
   Vildan Çetkin, Halis Aygün

2. **On Lowen type fuzzy soft topological spaces**
   Abdülkadir Aygunoğlu, Ebru Aydoğdu, Halis Aygün

3. **Fuzzy Type-2 Soft Sets**
   Banu Pazar Varol, Halis Aygün

4. **An Application on Decision Making Problem By Using Intuitionistic Fuzzy Parameterized Fuzzy Soft Expert Sets**
   Hilal Dönmez, Serdar Enginoglu

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Thursday, 19:00 Gala Dinner at **Yildiz Çatı Restaurant**
Friday, 09:00-10:30, Hall 1
Session: Fuzzy Forecasting-2
Chair: Çağdaş Hakan Aladağ

1. **Using Hybrid GA-ANN for Weather Forecasting**  
   *Mustafa Göçken, Aslı Boru, Ayşe Tuğba Dosdoğru*

2. **Forecasting Energy Production with Neuro-Fuzzy Approaches**  
   *Gültekin Atalık, Özer Özdemir, Sevil Şentürk*

3. **Modelling The Wind Energy with ANFIS and ANN**  
   *Sevil Şentürk, Gültekin Atalık, Özer Özdemir*

4. **Recurrent ANFIS for Time Series Forecasting**  
   *Busenur Sarica, Erol Egrioglu, Baris Asikgil*

5. **Prediction of Short-Term Passenger Flow in Bus Rapid Transit**  
   *Engin Pekel, Selin Soner Kara*

6. **A New Probabilistic Fuzzy Time Series Method**  
   *Erol Eğrioglu, Eren Baş, Çağdaş Hakan Aladağ, Ufuk Yolcu*

Friday, 09:00-10:30, Hall 2
Session: Fuzzy Multi-Objective Decision Making
Chair: Eren Özcaylan

1. **A Fuzzy Hybrid Model for Supplier Selection and Order Allocation**  
   *Alptekin Ulutas, Burak Ozdemir*

2. **A Fuzzy Multi-Objective Programming Model for the Single Period Stochastic Inventory Problem**  
   *Ahmet Sabri Öğütlü, Servet Hasgül*

3. **A Novel Constrained Fuzzy Arithmetic Based Decoding Procedure for Direct Solution of Fully Fuzzy Transportation Problems**  
   *Adil Baykasoğlu, Kemal Subulan*

4. **Closed-Loop Supply Chain Network Design Problem based on Operational and Social Measures: A Robust Possibilistic Programming Approach**  
   *Eren Özceylan, Mohamadreza Fazli Khalaf, Mir Saman Pishvaaee*

5. **A new augmented weighted Tchebycheff approach for solving supplier selection problems under volume discount**  
   *A. Baghban, S. Chitgar, S.H. Nasseri*
Friday, 10:45-12:00, Hall 1
Session: Fuzzy Mathematics-2
Chair: İ. Burhan Türkşen

1. On the Solution of the Fully Fuzzy Sylvester Matrix Equation
   Mohammad Keyanpour, Davod Khojasteh Salkuyeh, Hossein Moosaei, Saeed Ketabchi

2. A Fuzzy Logic Approach in Optimization of Multi-Response Surface in Machining Process
   Ali İhsan Boyacı, Tuğçen Hatipoğlu, Erhan Balca

3. A Comparison Among The Convergent, Cesàro Convergent and Riesz Convergent Sequences of Fuzzy Numbers
   Serdar Enginoglu, Serkan Demiriz

4. $\delta$-primary Fuzzy Ideals
   Deniz Sönmez, Gürsel Yeşilot

5. On the Solutions of Fractional Riccati Differential Equation with Fuzzy Initial Condition
   Cihan Aksop, Mehmet Merdan, Tahir Khanıyev, İ. Burhan Türkşen

6. Vague Soft Gamma Rings and Idealistic Vague Soft Gamma Rings
   M. Bolat, B. A. Ersoy, S. Onar, B. Davvaz

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Friday, 10:45-12:00, Hall 2
Session: Fuzzy Multi Criteria Decision Making-2
Chair: Gülcin Büyüközkan

1. Determining Relative Efficiency of Turkish Provinces According to Their Resource Utilization by Classic and Fuzzy Data Envelopment Analysis Methods
   Nurcan Deniz, Kadir Özgür Peker

2. A Multiple Criteria Group Decision Making Methods on Single Valued Trapezoidal Neutrosophic Numbers Based on Einstein Operations
   İrfan Deli, İrfan Şimşek, Naim Çağman

3. A Decision Making Method by Combining TOPSIS and Grey Relation Method under Fuzzy Soft Sets
   Selim Eraslan, Naim Çağman

4. A comparison of integration of Geographic Information Systems with Fuzzy AHP and Fuzzy TOPSIS in Location Analysis
   İsmail Önden, Özlem Gürel, Fahrettin Eldemir

5. Expected Value of SV-Trapezoidal Neutrosophic Numbers and its Applications to Multi-Attribute Decision Making Problems
   İrfan Şimşek, İrfan Deli

   Gülcin Büyüközkan, Fethullah Göçer
Friday, 13:00-14:30, Hall 1
Session: Fuzzy Multi Criteria Decision Making-3
Chair: Selcuk Cebi

1. Weighting the Criteria of Calibration Supplier Selection Problem with Fuzzy AHP in a Group Decision
   Nihal Erginel, Gamze Küçük

2. Selection of the Best Third-Party Logistics Companies with Fuzzy Analytic Network Process
   Yonca Binici, Sevil Şentürk, Özer Özdemir

3. ERP Software Selection For A Company with Fuzzy Analytic Hierarchy Process (FAHP) Method
   Cemil Çelik, Atakan Alkan, Gizem Doğan, Zerrin Aladağ

4. Using fuzzy AHP and conjoint analysis to identify importance degrees of parameters on academic performance
   Selcuk Cebi, Mehmet Guray Guler, Esra Ilbahar

5. The Evaluating Shopping Mall Locations Based on Fuzzy AHP Integrated Fuzzy VIKOR
   Ebru Pekel, Begüm Balta

   Yakup Çelikbilek, Fatih Tüysüz

Friday, 13:00-14:30, Hall 2
Session: Fuzzy Systems Applications
Chair: Rifat Gürcan Özdemir

1. Fuzzy Real Option Valuation in a Solar Energy Investment Project
   Oktay Taş, Hüseyin Yiğit Ersen

2. Modeling Uncertainty in Operators’ Statements in Measuring the Performance of a Continuous Production Line
   Volkan Sönmez, Özlem Müge Testik

3. Integrated Fuzzy Monte Carlo Simulation Model and Branch and Bound Algorithm for Solving Scheduling in Filling Process
   Rifat Gürcan Özdemir, Zeki Ayağ

   Mehmet Bayram, Muzaffer Akat

5. On Solving Transportation Problems with Interval-Valued Trapezoidal Fuzzy Numbers
   Ali Ebrahimnejad, Seyed Hadi Nasseri, Roghayeh Chameh
Friday, 14:45-16:15, Hall 1
Session: Type-2 Fuzzy Sets
Chair: Nezir Aydin

1. A Systematic Type-2 Fuzzy Modelling Methodology for Time Series Forecasting
   M. Furkan Dodurka, Atakan Sahin, Tufan Kumbasar, Engin Yesil, and Sarven Siradag

2. Strategy Selection via Hierarchical Type-2 Fuzzy “TOPSIS-DEMATEL” Approach
   Adil Baykasoğlu, İlker Gölcük

3. A passenger satisfaction approach based on interval type-2 fuzzy sets for rail transit system
   Erkan Celik, Alev Taskin Gumus, Nezir Aydin

4. Fuzzy Modeling for Replicated Response Measures by Using Type-2 Fuzzy Numbers
   Özlem Türkşen, Ozan Kocadağlı

5. An interval type-2 fuzzy approach for evaluating humanitarian relief logistics performance of non-governmental organizations
   Erkan Celik, Alev Taskin Gumus

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Friday, 14:45-16:15, Hall 2
Session: Fuzzy Systems Applications in Health Science
Chair: Harun Taşkin

1. Project management in healthcare: A case for evaluating patient flow of an emergency room with fuzzy CPM and fuzzy PERT
   Muhammet Gul, Ali Fuat Gunerli, Gizem Gunes

   Ünal Atakan Kahraman, Harun Taşkin

3. An Integrated AHP and Fuzzy MOORA Methodology for Medical Company Selection in Health Sector
   Şeyma Yayla, Sinan Öztaş, Betül Turanoğlu, Gökay Akkaya

4. Fuzzy MCDM Usage in Healthcare Service Quality Literature
   Nurcan Deniz
Friday, 16:30-18:00, Hall 1
Session: Fuzzy Expert Systems
Chair: Türkay Dereli

1. **Effect of Rule Evaluation in Hierarchical Systems: A Benchmark on XOR Gate**
   
   Begüm Mutlu, Ebru A. Sezer, Hakan A. Nefeslioğlu

2. **A bibliometric analysis of research related to fuzzy association rules**
   
   Serkan Altuntas, Türkay Dereli, Koray Altun, Meriç Menay

3. **Linguistic Summarization of Restaurant Evaluation Data Set Using Type-I and Type-II Fuzzy Quantified Sentence**
   
   Betül Dündar, Suat Özdemir, Diyar Akay

4. **Fuzzy version of the Jalan-Ravallion’s approach: evidence from Tunisia**
   
   A. Jmaii , B. Belhadj

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Friday, 16:30-18:00, Hall 2
Session: Fuzzy Control-2
Chair: Abdoulaye Sere

1. **Handling Uncertainties in the Connection of PHEVs to Smart Grid Using Fuzzy Logi**
   
   Samaneh Yazdanipour, Gholamreza Latif Shabgahi

2. **A Hough Transform based on a Map-Reduce algorithm**
   
   Abdoulaye Sere, Dario Colazzo, Oumarou Sie

3. **Fuzzy Based Flux Oriented Direct Torque Control Of Induction Motor**
   
   Yavuz User, Suleyman Bilgin, Kayhan Gulez

4. **Comparative Analysis of Performance of Fuzzy and Intuitionistic Fuzzy Similarity Measures on Noise Added Images**
   
   Fatih Kutlu, Ozkan Atan, Tunay Bilgin
ABSTRACTS
Hermite-Hadamard Type Inequality for Preinvex Functions via Sugeno Integrals

Sercan Turhan\textsuperscript{1}, Nurgül Okur Bekar\textsuperscript{1}, & Selehattin Maden\textsuperscript{2}
\textsuperscript{1}Department of Statistics, Faculty of Arts and Sciences, Giresun University, Giresun, CO 28100, TURKEY
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In this paper, Hermite-Hadamard type inequality for Sugeno integrals based on preinvex functions is studied. Some examples are given to illustrate the results.

New Operators on Fuzzy Sets: Modified Einstein Operators

Atınc Yılmaz\textsuperscript{1}, Seçkin Arı\textsuperscript{2}, & Ümit Kocabıçak\textsuperscript{2}
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The basic operations of union and intersection have been implemented by an infinity of operators on fuzzy sets. In this paper, a t-norm and t-conorm operator for fuzzy sets has been proposed. The proposed operator's t-norm and s-norm equations have been derived as other alternatives to algebraic product and possibility sum operators. After having introduced the concepts, this paper will try to compare the operators.

Approximate solution of fuzzy second order differential equations

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In this paper, a second order fuzzy initial value problem under strongly generalized differentiability by means of the Homotopy Analysis method (HAM) is considered. Approximate solution in the form of a rapidly convergent series with easily computable components using symbolic computation software is provided. Although the homotopy analysis method (HAM) contains the auxiliary parameter, the convergence region of the series solution can be controlled in a simple way. To illustrate the accuracy and applicability of the proposed method numerical example is presented.
The main objective of clustering is to identify a natural structure of subsets of data set. Most of the clustering methods, based on this idea, use distance functions. On the other hand, learning the appropriate distance function is a difficult task in applications. Thus, in order to get high accuracy in clustering/classification, similarities are used rather than distance functions. In this study we will extend a recent and efficient classification algorithm proposed by Kayaalp and Arslan (2014) for data sets including not only numerical type of attributes but also categorical type of attributes. Hence, natural structure of the data set will be discovered and it will be used for the classification method. An important step in this algorithm is to construct clusters and their fuzzy membership functions which will be used in Bayesian classification.

Fuzzy Isomorphism Theorems of Idealistic Soft Gamma Rings

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²Mathematical Department, Yazd University, IRAN

In this paper some basic definitions of soft set theory and fuzzy set theory are given. Then the concept of fuzzy isomorphism theorems of idealistic soft gamma rings are introduced. The first, second and third fuzzy gamma isomorphism theorems of idealistic soft gamma rings are established and their proofs are given, respectively. Moreover, several basic conclusions are given.

An extended RQFD method using 2-tuples representation model

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In this paper some basic definitions of soft set theory and fuzzy set theory are given. Then the concept of fuzzy isomorphism theorems of idealistic soft gamma rings are introduced. The first, second and third fuzzy gamma isomorphism theorems of idealistic soft gamma rings are established and their proofs are given, respectively. Moreover, several basic conclusions are given.
Sediment Modelling Using Multi-criteria Decision Making Fuzzy TOPSIS: A Case Study of Lighvan

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Multi-criteria decision making are effective framework for comparing different criteria. Knowing sediment phenomenon and estimating sediment load causes optimized usage of water utilities (like dam) and prevents waste expenses because of complexity of natural systems and limitation in sediment measured observances, ordinary empirical relations, cannot estimate the lakes sediment load correctly. For modelling complex imprecise and in complete data, fuzzy model is recommended. If the process he complex and relating to various factors one of the best methods will be fuzzy TOPSIS. In this research for estimating monthly suspended sediment loads in Lighvan catchment in east Azarbayjan province, we used this method and compared the results with Observed data. Because sediment, runoff and rainfall parameters are non-precise and also sediment load is effected by many factors, so multi-criteria fuzzy TOPSIS decision making is a suitable means for sediment load modelling efficiency criteria prove this. The near-accurate predictions achieved for the sediment load (correlation coefficient of about 0.863, Nash-Sutcliffe of about 0.744 and root mean square error of about 182.07) indicate the appropriateness of the fuzzy TOPSIS approach for characterizing and predicting the sediment load at the Lighvan catchment.

An Application For Supplier Evaluation Process In Construction Sector Through Fuzzy PROMETHEE Method

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With increasing competition, high performance of organizations does not only depend on their individual performance but also on the performance of the other associates in the supply chain. Given the significant impact of the associates, it is clear that selection of a supplier is of great importance for organizations. In the present study, one of the decision making techniques, Fuzzy PROMETHEE technique, was employed to compare prefab suppliers for an international construction firm. Fuzzy sets were used to get rid of uncertainties in the evaluation process and due to easiness they offer to get the evaluation of decision makers orally. Supplier performances of the firm were evaluated and both partial and complete ordering was determined for alternative suppliers.
Determining Service Attributes of Airline Transportation Industry with Fuzzy QFD Method: An Application in Turkey

Elif Kılıç Delice¹, Burcu Yılmaz Kaya² & Metin Dağdeviren²
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²Gazi University, Ankara 06570 TURKEY

In competition environment of present days, entrepreneurs prefer to run in service sector than manufacturing because of the lower investment costs and expenditures, higher possibility of rapid grow and niches in the markets. Airline transportation market has one of the largest shares in this sector, but besides its glamour, it is difficult to assess effectiveness, efficiency or quality in service sector. Hence ensuring high customer satisfaction is very important as a key factor to success in this market, analysis of customer needs (CNs) take an important role for this goal. In this paper, fuzzy Quality Function Deployment (QFD) is used to understand CNs and determine the service attributes (SAs) for airline transportation industry under fuzzy environment. The majority of input in the QFD process is formed as linguistic data, which is inherently vague, or which varies with human perception and judgement about the importance of the CNs, SAs. To show the validity of fuzzy QFD method, a real world application is executed in the domestic airline transportation industry of Turkey. Finally, this study ensured managers and designers to obtain critical SAs in order to gain the best airline transportation company development strategy for higher customer satisfaction.

Proposal of New Performance Measures & Total Productive Maintenance Performance Measurement under Fuzzy Environment

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Total Productive Maintenance (TPM) is a successful technique that is important in identifying the success and overall effectiveness of manufacturing processes for long term economic viability of businesses. Overall equipment effectiveness (OEE) is commonly used and well-accepted metric for TPM implementation in many manufacturing industries. According to the literature review, the performance elements measured by the OEE tool, even though they are important, are not sufficient to describe the effectiveness of a production system. Hence, the aim of this study is to develop new performance measures oriented towards the quantification of TPM implementation effectiveness and evaluate the new performance measures in TPM under fuzzy environment. Our study helps operators and executives to visualize the results of the investments made in TPM efforts.
Technology Competency Evaluation of SMES in the Turkish Manufacturing Sector by a Multi Criteria Decision Making Approach

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Technology and management competence determines capabilities of firms to compete in the sector and has a critical importance for the innovative researches and development of the companies. In this study, a fuzzy multi-criteria decision making model is proposed to evaluate the performances of manufacturing companies in Istanbul, Turkey. A hierarchical performance evaluation model is structured based on the six main competency dimensions that are selected by expert evaluation and based on literature review. Small and medium-sized enterprises (SMEs) are analyzed and evaluated with respect to technology evaluation surveys in which processes management, products, information and communication technology, marketing strategy, innovation and entrepreneurial activities and research and developments (R&D) issues are investigated. Fuzzy analytic hierarchy process (FAHP) method is used to determine the weights of the criteria. These criteria weights and responses of survey analysis (data) related with the company are input to the VIKOR method to rank the companies.

Evaluation of CRM and BI criteria using a fuzzy multi criteria decision making approach for the textile industry

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²Textile Design Department, University of Gazi, Golbasi Yerleskesi 06860, Golbasi, Ankara, TURKEY

Textile and apparel sector plays an important role for the economic development in Turkey. Many companies are making significant investments in decision making systems. Textile and apparel companies are working under intense market pressure that compels to enhance all the capabilities. Companies are heading towards either Customer Relationship Management systems to maintain loyal customers, or Information Technologies such as Business Intelligence to expand markets and to create value-added marketing opportunities. The aim of this paper is to investigate the possibility of a CRM and BI system with fuzzy multi criteria decision making approach for the Turkish textile and apparel sector. An explanatory case study was undertaken to identify the main factors of both CRM and BI. By enhancing the abilities provided by business intelligent systems as a set of customized and interactive experience to respond directly to customer requests and manage production in this regard will result in companies with a sustainable ability to establish and nurture long-term customer loyalty in the sector than ever before. Furthermore, this study will provide essential information to develop appropriate business intelligence and customer relationship strategies for the Turkish textile and apparel industry, since the main idea underlying it is to identify main factors influencing BI and CRM characteristics as well as to create a Business Intelligence system tailored-fit with relevant customer relationship management criteria working in the textile sector.
Preliminary Design of Aircraft Fuselage Dimensions for Various Flight Performances by ANFIS Subtractive Clustering Method

Khalil Shamsi, Mohammad H. Sabour, Farhad Ahadi Koloo & Morteza Mohammadzaheri

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Initial estimation of the overall dimensions of fuselage is one of the most important steps in aircraft design. The systems and sub-systems of the fuselage will be designed in details in the next stage. None of the articles discuss the precise relationship for fuselage dimensions. In this paper, the identification of the most effective parameters on the overall fuselage dimensions as well as their impact on the fuselage of the aircraft conceptual model are studied. Firstly, according to statistical methods, endurance, altitude, and takeoff weight have been detected as the most effective parameters to determine the fuselage dimensions (maximum length, maximum width and maximum height). Secondly, the impact of each parameter has been investigated through the adaptive neuro-fuzzy inference system and fuzzy clustering process. The system model identification has been implemented by MATLAB programing of ANFIS as a strong universal estimator. As the system output, identification results showed the ANFIS high performance and its capability for acceptable precision of system approximation. To validate the output, a set of specified statistical data has been considered as the test data. It was observed that the extracted dimensions from the ANFIS model and that of the actual model are too close.

Retinal Blood Vessel Extraction using image enhancement and Fuzzy C-means Clustering

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Retinal blood vessel segmentation is an important step for diagnosis of retinal diseases. An automatic vessel extraction technique can help specialist for this purpose. In this paper a novel method is employed to extract vessel structures in retinal fundus images. Firstly, an enhancement procedure including Gabor Filter is performed to increase contrast between vessels and background after a preprocessing step. Afterward, top-hat transform is applied to gabor filter response in order to make blood vessels more accurate. The output of the transformations is converted to binary image with a modified Fuzzy C-means clustering method. The images obtained from STARE and DRIVE databases which are available on the internet are used in order to test the developed system. Finally, 95.63% of accuracy for STARE database and 95.80% of accuracy for DRIVE database are obtained which are promising.
3. A New Evaluation Approach for Supplier Selection System

M. Bahar Başkır¹, İ. Burhan Türkşen² & Ömer Saatçioğlu³
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Supplier selection and evaluation systems are vagueness and imprecision due to having qualitative and quantitative procedures. In this study, we propose a new supplier selection and evaluation framework integrated by fuzzy c-means, belief-based quality function deployment and a proposed fuzzy decision measure. In particular, we focus on finding and improving the source of uncertainty based on supplier selection system for a Turkish Machinery Corporation. We separate supplier assessments in the Corporation into two parts: (i) Expert assessments with the use of belief-based quality function deployment, (ii) System assessments comprised by multi input-single output system. Then, we investigate the uncertainties of these two assessment parts by fuzzy c-means algorithm. Eventually, we propose a fuzzy decision measure to rank suppliers and to select the bests.

An Analysis of Neural Network-Based Fuzzy Time Series Methods in Turkey

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Fuzzy time series has an important role for time series modeling and forecasting for many areas such as economical, educational, environmental and seasonal data. Recently, wind energy became popular for this kind of studies. Although there are many studies about explaining wind energy variables, modeling energy production based on wind energy variables are needed to be investigated by a comparison study using neural network-based fuzzy time series methods. By using these methods with artificial neural networks, the best method for modeling and forecasting of wind energy will be determined with based on some performance measures called as mean absolute percentage error (MAPE), root mean squared error (RMSE), mean squared error (MSE) and mean absolute error (MAE). The better results shall be obtained by different parameter values of methods.
Review Study on Fuzzy Time Series and Their Applications in the Last Fifteen Years

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Since the first paper on fuzzy sets, which is published by Professor Lotfi Zadeh in 1965, fuzzy sets and systems have witnessed a remarkable advancement in theory and applications. Over these fifty years, fuzzy systems have been successfully applied in various fields. Fuzzy sets have also strongly influenced research and development in other areas of computational intelligence leading to many hybrid systems. In this paper, a review on the fuzzy time series which is one of the most interesting area of fuzzy sets applications, is presented. This review paper focuses on the important papers published within the last 15 years, and discusses hybrid methods used in fuzzy time series. Especially, the theoretical papers, which includes different clustering methods, PCA, Hidden Markov Methods, different global optimization approaches, support vector machines, and the many application papers are presented in details, then the novelty of these papers are discussed with comparisons. Furthermore, in this review study, the existing fuzzy time series approaches are investigated in five section according to fuzzy time series modelling steps and modelling with type-2 fuzzy sets.

Improving Evaluation System of Program Educational Objectives and Outcomes Based on MUDEK Criteria Using Fuzzy Approach

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In this study, we propose an integrated fuzzy evaluation system that can be used by an engineering program for evaluating output-based criteria for which survey method is used during a self-assessment process. Uncertainties arise from using the Likert scale whose cognitive dimension varies among the experts due to their differences in ways of thinking, level of knowledge and perception, ability to express themselves, and the adequacy of the given scale in measuring their opinions. In addition, widely used classical (weighted) average is not effective in identifying these uncertainties. We present phases of the evaluation system and its uncertainty description due to having subjective assessment procedures. We evaluate expert assessments using a fuzzy weighted average method. After calculating balance points of these assessments, we analyze uncertainties of these points via fuzzy clustering technique. The proposed system is applied for an undergraduate engineering program in Turkey, which is accredited by the Association for Evaluation and Accreditation of Engineering Programs (MÜDEK). We find that the fuzzy approach yields more sensitive evaluations compared to the classical (weighted) average method under subjective assessment.
Fuzzy Logic-Based Inquiry Approach on Oracle Database and the Application of Special Software

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In this study, conventional database system on the fuzzy set theory, probability theory and fuzzy logic has been developed using a flexible query interface. The study used data from a University of Foreign Languages High School student. Preparation of students, evaluation of student achievement data, fuzzy queries, notes the absence of flexible solutions through a decision-maker is presented. In this study, student achievement is calculated by conventional methods with the results of computer programs, this software is developed using fuzzy logic results were compared with calculations. Assessment of the contribution of science and technology in developing educational measurement and evaluation of classical measurement, educational, Fuzzy Logic as an alternative measure is presented. As a result of this study, based on a flexible logic, which belongs to a set of successful in the vast majority of students, interpret this as a failure observed in classical logic. Therefore, learning to measure the success of students with a definite value, and this value is not possible to use it without subjecting them to any review.

Use of Fuzzy Approaches to Make Predictions on Small Sized Data

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Data driven methods learn from samples and qualification of samples based on their distribution on the n-dimensional input space and also their number. Actually, samples are assumed as smart summary of the problem space. Inadequate number of samples almost means that there is no smart summary for the input space; as a result, generalization ability of the models obtained by learning from small size data cannot be high as much as needed. In this study, the performances of fuzzy approaches are investigated for learning from expert and data to overcome the problem of small sized data. Mamdani style Fuzzy Inference System (FIS) is used as expert based method, Artificial Neural Network (ANN) and Adaptive Neuro Fuzzy Inference System (ANFIS) are used as data driven methods. Fuzzy C-Means used for producing synthetic data to enrich the number of samples for modeling with ANN and ANFIS. According to experimental results, use of synthetic data produced by FCM to train ANFIS is more successful (R²:0.782, VAF:0.87, RMSE:0.262) than ANN (R²:0.728, VAF:0.73, RMSE:0.43) and this result can be interpreted as handling of fuzziness only in synthetic data generation phase is not enough and predictive model also
should handle fuzziness while dealing with small sized data. General performance of FIS is not good as much as employed data driven methods but it is an acceptable level (R2:0.714, VAF:0.69, RMSE:0.59). Thus while working with small sized data, the performance of expert based prediction can be used as threshold to assess the performance of any data driven method as successful.

**Generalized Maximum Fuzzy Entropy Methods with Applications**

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Generalized entropy optimization methods are applied in many scientific fields. In particular, a modification of this method for requirements of fuzzy entropy analysis is very important. For this reason, we propose a new modification of generalized entropy optimization methods on a finite fuzzy set in the sense of Max(F)Ent measure. Generalized Maximum Fuzzy Entropy Methods (GMax(F)EntM) in the form of MinMax(F)EntM and MaxMax(F)EntM are suggested on the basis of primary maximizing Max(F)Ent measure for fixed Max(F)Ent characterizing moment which generates corresponding to moment constraints in order to obtain the special functional with Max(F)Ent values and secondary optimization of mentioned functional with respect to Max(F)Ent characterizing moment vector functions. Distribution, in other words a set of successive values of estimated membership function closest to (furthest from) the given membership function in the sense of Max(F)Ent measure, obtained by mentioned methods are defined as $(\text{MinMax}(F)\text{Ent})_m$ which is closest to a given membership function and $(\text{MaxMax}(F)\text{Ent})_m$ which is furthest from a given membership function. In this study, fuzzy data analysis is fulfilled by applying GMax(F)EntM for wind speed data measured in 1999. The performances of distributions $(\text{MinMax}(F)\text{Ent})_m$, $(\text{MaxMax}(F)\text{Ent})_m$ are established by Chi-Square, Root Mean Square criteria and Max(F)Ent measure. It should be noted that the results are obtained by using MATLAB.
Risk assessment model of elevator equipment failure based on fuzzy logic

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Due to the large number of fatal occupational accidents that occurred in construction industry, the occupational health and safety management is a vital issue for Turkey in recent years. In this context for high-quality maintenance of the technical systems in constructions, it is necessary to evaluate risk assessment of machinery and its elements in order to determine sensitive elements in the system which are inclined to failures. Failure mode and effects analysis (FMEA) is an effective risk assessment tool used to define and reduce potential failures in products, processes or systems before they occur. This paper presents a model of the risk assessment of elevator systems in constructions failure based on the fuzzy logic, fuzzy sets theory and min-max composition. However, this paper explains the benefits of fuzzy model when compared to a standard procedure of risk priority number (RPN) calculating-in the FMEA method.

Fuzzy based human reliability assessment upon cargo discharging operation on-board chemical tanker ship

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Safety is core topic in marine industry since various kinds of commodities being transported with ship in particular harmful substances such as chemical products. Due to hazardous inherent of chemical cargoes, cargo operation on-board chemical tanker ships always pose potential damage to human life, marine environment and ship. Therefore, ship crew shall be fully aware of the operational errors especially in cargo discharging operation. At this point, human reliability become a significant issue in sustainable transportation of chemical commodity. In the context of human reliability assessment, this paper presents a proactive tool to assess human error probability (HEP) towards cargo discharging operation on-board chemical tanker ships to enhance safety in marine industry as well as environment protection. In the proposed approach, while HEART (Human Error Assessment and Reduction Technique) method enables to evaluate probability of human error, fuzzy sets overcome the vagueness of expert judgments and expression in decision-making. Besides practical contributions in reliability assessment in chemical tanker ships, the paper has theoretical insights. In conclusion, the outcomes of the research contribute monitoring the performance of crew in terms of conditional reliability as well as enhancement of safety in marine industry.
Risk Assessment with Fuzzy L Type (5x5) Matrix Method

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Risk assessments have become one of the major management tools for companies due to legal regulations in occupational health and safety. Identifying and grading risks address to provide actions in methodologic way to eliminate the risks and help to improve work processes at the same time in companies. Many risk assessment methods exist in applications. One of the biggest problems in those methods is being dependent of evaluator’s initiative.

In this study, L type (5x5) matrix method, which is used frequently as a risk assessment method, has been discussed and fuzzy approach has been proposed for this method. In L type (5x5) matrix method, risks are evaluated in five different groups as negligible risks, acceptable risks, mid-level risks, important risks and unacceptable risks when probability and intensity parameters are considered. In the study, probability, severity and risk groups will be taken into consideration as fuzzy numbers with the proposed method and subjectivity of a user will be decreased in this way. L type (5x5) matrix method and fuzzy L type (5x5) matrix method which has been proposed in the study will be applied in a production company to analyze its risks and results of those methods will be compared and discussed.
Dynamic Performance Analysis of Self-Tuning Fuzzy-PID Controller for the Inverted Pendulum System

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Creating a very real system sub-model of the inverted pendulum system, nonlinear dynamic model and unstable equilibrium points is one of the major reasons for preferring research purposes. The coefficients of the conventional PID controller are not often properly tuned for the nonlinear plant with unpredictable parameter variations. Hence, it is necessary to automatically tune the PID parameters. In this paper, self-tuning Fuzzy-PID controller is developed to improve the performance of the inverted pendulum.

Investigation of PID and Self-Tuning Fuzzy PID Controller Achievements for Level and Temperature Control of the Mixing Tank

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Liquid level and temperature control is the most important part of the system layout in many industrial plants. Failure to make the optimum control of liquid level and temperature can lead to moral and material damages for these plants in some cases. Fuzzy logic based control and traditional control methods are used in many applications. Self-Tuning Fuzzy-PID controller means that the three parameters Kp, Ki, and Kd of PID controller are tuned using fuzzy tuner. In this study, water tank, which is a nonlinear multi input multi output system, is simulated by MATLAB/Simulink using PID and Self-Tuning Fuzzy PID Controller.
Fuzzy Logic Based Indirect Vector Control of Squirrel Cage Induction Motor

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Squirrel cage induction motors are widely used in industry. These induction motors need smart control applications for high performance. In this paper an indirect vector control of squirrel cage induction motor is modelled mathematically. The mathematical model is moved to simulation using Matlab/Simulink software. For improvement, the indirect vector control simulation is based on fuzzy logic. Eventually, fuzzy logic speed control of induction motor simulation results are obtained for different reference speeds. The results showed effectiveness of fuzzy control system for indirect vector control of squirrel cage induction motor simulation model.

Intelligent Control of Lotka–Volterra Chaotic System using State Feedbacks and ANFIS

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This study presents an intelligent control of a predator-prey Lotka–Volterra chaotic system. According to its differential equations, the Lotka–Volterra chaotic system is described briefly. A hybrid control method including Adaptive Neuro-Fuzzy Inference System (ANFIS) and state feedbacks is proposed for the control. Thus, the advantages of linear feedback control and ANFIS control methods are combined. Numerical simulations are demonstrated to verify the feasibility of the proposed method. Simulation results also show that the controlled Lotka–Volterra system effectively stabilizes towards its equilibrium points in the state space.
Automotive airbag fuzzy rule-base constructed control system by real data collection

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Data analysis, approximate reasoning and modeling are some fuzzy methods and applications which are able to process dynamic systems. The inputs of fuzzy logic would be appraised by some combinations of linguistic variables which are gathered in a fuzzy rule base to determine the precise outputs. In this article, the fuzzy modeling of high risk accident scenarios of passenger cars has been considered for controller design purpose. For this modeling, collected data form eighty high risk accident cases containing the type and severity of accidents is sent to Supplemental Restraint System control unit by different sensors to analyze and use in modeling. After analyzing data, the relationship among them was determined and a model of high-risk situations was constructed. Proper and precise definitions of the parameters of successful modeling and relations among them in fuzzy rule base, directly affects safety belt pre-tensioners and airbag control system.
Lowen Functors in Fuzzy Soft Topological Spaces

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The aim of this study is to extend the Lowen functors to fuzzy soft topological spaces and study their fundamental properties. For this reason, firstly, we define fuzzifying soft topology which will be compatible with the fuzzy soft theory and investigate some of its basic properties. Secondly, we induce a fuzzifying soft topology from a given fuzzifying soft base. Also, we obtain an initial fuzzifying soft topology and give the definition of the product fuzzifying soft topology. Moreover, we prove that the category of fuzzifying soft topological spaces FYSSTOP is a topological category over $\mathcal{S}$.

Moreover, we investigate the categorical relations between fuzzy soft topological spaces and fuzzifying soft topological spaces by generalizing the Lowen functors.

On Lowen Type Fuzzy Soft Topological Spaces

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The aim of this study is to define fuzzy soft topology which is based on the idea of fuzzy topology in Lowen's sense and investigate some of its fundamental properties. Firstly, we give a representation of fuzzy soft sets and recall some basic properties of fuzzy soft sets according to this representation. Secondly, we introduce fuzzy soft topology in Lowen's sense and define fuzzy soft continuity of a mapping. Finally, we give the definition of a fuzzy soft point, the definition of neighborhood of a fuzzy soft point and study some basic properties of them.

Fuzzy Type-2 Soft Sets

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In 1999, D. Molodtsov initiated the concept of soft sets as a useful mathematical tool for modeling uncertainty. Then, in 2001 Maji et al. combined soft sets and fuzzy sets and introduced the concept of fuzzy soft sets. In this work, we first define the fuzzy type-2 soft sets and their operations. By using them, we then give some results and an application of fuzzy type-2 soft sets in the form of a decision making problem.
An Application on Decision Making Problem by Using Intuitionistic Fuzzy Parameterized Intuitionistic Fuzzy Soft Expert Sets

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In this paper, we first introduce the concept of intuitionistic fuzzy parameterized intuitionistic fuzzy soft expert sets which is a generalization of the soft expert sets and study some properties of them. We finally give an application which shows that this concept successfully applicable on decision making problems.
Using Hybrid GA-ANN for Improved Weather Forecasting

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In recent years, various techniques have been used for analyzing dynamic behavior of the weather. These are ranging from simple mathematical methods and expert systems to artificial intelligence. One of the most useful forecasting methods for weather analysis is Artificial Neural Network (ANN). ANN offers many advantages for solving complex nonlinear relationships between input and output variables. On the other hand, designing ANN is critical. There is no general rule to decide suitable ANN structure that is basically problem specific. Therefore, we used Genetic Algorithm (GA) to determine optimum number of input variables and neurons in hidden layer. Also, D_Min_Max data normalization method which makes inputs dimensionless is used. The observations of the weather data between 01/01/1970 and 31/12/2012 has been supplied from “Turkish State Meteorological Service” for Adana. To evaluate the forecasting performance of the developed methodology, the indicators of the accuracy of mean square error (MSE), mean absolute error (MAE), mean absolute percent error (MAPE) and root mean square error (RMSE) are used. The results show that GA-ANN is better than Single ANN because GA-ANN has an ability of capturing the advantages of both types of methods simultaneously.

Forecasting Energy Production with Neuro-Fuzzy Approaches

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Decrease of oil reserves and global warming make renewable energy sources very important. Because of this reason many studies and researches have been done on renewable energy sources. The wind energy is one of popular green energy sources and it continues to be growing power generating technology due to its availability and low cost. Turkey has considerable wind energy potential. However, this potential is not actively used in energy production. It is important to determine wind energy potential in Turkey, it is related to establish new wind farms in terms of reducing dependence to other countries. Adaptive neuro-fuzzy inference systems (ANFIS) consists of combination of fuzzy logic and neural networks. The aim of this study is to determine the most suitable technique for modelling wind power by the help of ANFIS and fuzzy time series.
Modelling the Wind Energy with ANFIS and ANN

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The wind energy is one of the most popular renewable energies in the world. Since Turkey is surrounded by seas on three sides, wind energy is becoming a popular renewable energy source. Modeling and estimation of wind energy are crucial problems on the renewable energy. Classical regression analysis is a well-known technique for modeling the wind energy to crisp inputs and outputs. The fuzzy set theory addresses the development of concepts and techniques for dealing with uncertainty and impression conditions for fuzzy inputs and outputs. Adaptive neuro fuzzy inference system (ANFIS) is an approach in fuzzy set theory. The aim of this paper is to model the wind energy in Marmara region by using classical regression, ANFIS and Artificial Neural Network (ANN). The developed models are performed and results are compared with RMSE criteria.

Recurrent ANFIS for Time Series Forecasting

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A few recurrent ANFIS approaches were proposed in the literature. Two main type recurrences is possible in ANFIS architecture. Feedback can be made for input layer or right sides of Sugeno-type rules. In this study, a new type recurrent ANFIS is proposed for forecasting. Feedback mechanism is embedded to ANFIS by using squares of error terms as inputs in right sides of Sugeno-type fuzzy rules. The training of the proposed ANFIS is made by using particle swarm optimization technique. The proposed method was tested on some real world time series data and it is compared with some alternative forecasting methods in the literature. It was shown that the proposed method has the best forecasting performance.
Prediction of Short-Term Passenger Flow in Bus Rapid Transit

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Prediction of short-term passenger flow is of a crucial importance in bus rapid transit. The results of prediction can be applied to meet the expectation of approximate passenger demand. However, the determination of the predictive pattern for the passenger demand is so tough to construct the relationship between passenger demand and the effecting factors such as weather condition. In this paper, adaptive neuro fuzzy inference system (ANFIS) is applied to forecast the passenger demand by regarding the effecting factors with hybrid optimization method in bus rapid transit (BRT). The experimental results point out that the adaptive neuro fuzzy can be successfully applied to determine the pattern between passenger demand and the effecting factors and provide accurate passenger demand information.

A New Probabilistic Fuzzy Time Series Method

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In the literature, many of forecasting methods have been proposed. There are various classifications of forecasting methods. Non-probabilistic forecasting methods such as artificial neural network, fuzzy inference systems and fuzzy time series methods have been commonly used in recent years. As a consequence of this, forecasting methods can be classified into two groups as probabilistic and non-probabilistic. Fuzzy time series methods are non-probabilistic forecasting methods. In the literature, many of fuzzy time series methods have been proposed but its distributions could not be obtained for forecasts in these methods. In this study, a new probabilistic fuzzy time series method was firstly proposed. The proposed method is based on moving block bootstrap method. It is possible to obtain distributions of forecasts by using the proposed method proposed in this study. The proposed method was applied to two real world time series data and also the performance of the proposed method was examined and compared with other forecasting methods.
A Fuzzy Hybrid Model for Supplier Selection and Order Allocation

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Supplier selection has become an important topic with the increasing of outsourcing activities of manufacturing companies. Supplier selection is a complex multi-criteria decision problem including qualitative and quantitative criteria, which may be uncertain. In this paper, we proposed a hybrid model including analytic network process (ANP), fuzzy additive radio assessment (fuzzy ARAS) and linear programming (LP) to reduce uncertainty in supplier selection problem. ANP is used to determine the weights of supplier selection criteria and fuzzy ARAS is used to assign a score to performance of suppliers against supplier selection criteria. After this, overall score of each supplier is put into a maximization objective function in linear programming (LP) as a coefficient. This overall score and fuzzy constraints (demand and supplier capacity) are analyzed in linear programming (LP) to select best suppliers and to allocate orders for these suppliers.

A Fuzzy Multi-Objective Programming Model for the Single Period Stochastic Inventory Problem

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The single period stochastic inventory problem is referred to as "Newsboy" or "Newsvendor" problem in the literature, and can be expressed as to determine the optimal order quantities under stochastic demand. Due to single order opportunity, the order quantity should be determined for the entire period. In most studies expected profit is used as the performance measure in the solution of the Newsboy problem. However, managers and decision makers may be more concerned with a probability level to achieve a specific target profit as another performance measure beside the expected profit maximization. These two performance measures are conflicted to each other, and cannot be optimized simultaneously. Therefore, in this study, a fuzzy multi-objective programming model is developed to find a good compromise solution to the problem. An illustrative example is presented to demonstrate the use of the proposed model.
A Novel Constrained Fuzzy Arithmetic Based Decoding Procedure for Direct Solution of Fully Fuzzy Transportation Problems

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In the recent literature, fully fuzzy mathematical programs in which all of the parameters as well as the decision variables are considered as fuzzy numbers is a new and hot research topic. In this study, a new direct solution approach is proposed for solving fuzzy transportation problems with fuzzy decision variables. In the proposed approach, a fuzzy decoding procedure including constrained fuzzy arithmetic concept and a meta-heuristic algorithm is employed. Moreover, the proposed approach is also able to handle the decision maker's attitude toward risk. In order to illustrate validity and practicality of the proposed approach, a numerical example for a balanced fully fuzzy transportation problem is presented and solved. It has been observed that more computational & information efficient results can be obtained by employing the proposed direct solution approach without any transformation. It was also shown that relatively more precise solutions can be produced by the proposed approach for risk-averse decision makers.

Closed-Loop Supply Chain Network Design Problem: A Robust Possibilistic Programming Approach

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Given recent concerns on the harmful consequences of supply chain activities on the environment and business opportunities on the society, it has become necessary to specifically take into account recycling when designing and managing a supply chain network. A supply chain in which forward and reverse supply chain activities are integrated is said to be closed-loop supply chain (CLSC). In this study, we offer a mathematical model that not only minimizes operational costs associated with transportation and facility set-up, but also maximizes the first and second hand product sales for a closed-loop supply chain network. To cope with uncertainty inherent to the CLSC network, a robust possibilistic programming approach is applied. The performance and applicability of the robust possibilistic programming approach on CLSC network design problem is illustrated via a numerical example.
A new augmented weighted Tchebycheff approach for solving supplier selection problems under volume discount

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In order to achieve a compromised solution for a fuzzy multi-objective problem, Tchebycheff norm and a new approach based on \( \bar{A} \) cut is suggested to minimize the distance from the current estimate of the objective values from the ideal point. Since the obtained solutions by the Tchebycheff approach are weakly efficient for multi-objective problems. Hence, an augmented weighted Tchebycheff norm has been proposed. Here, the satisficing tradeoff algorithm is used to solve the augmented weighted Tchebycheff problems. Since the supplier selection problem is usually a multi-objective problem, the augmented weighted Tchebycheff method is applied for obtaining its solutions.
On the Solution of the Fully Fuzzy Sylvester Matrix Equation

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The aim of this paper is to propose a method to solve fully fuzzy Sylvester equation (FFSE)

\[ \mathbf{A} + \mathbf{B} = \mathbf{C} \],

where \( \mathbf{A}, \mathbf{B}, \) and \( \mathbf{C} \) are fuzzy matrices. By using of \( \alpha \)-cutting, FFSE is transformed to a generalized Sylvester matrix equation, and then to a crisp system of linear equations. The existence and uniqueness of a solution to this system are investigated. Two numerical examples are given to illustrate the proposed method.

A Fuzzy Logic Approach in Optimization of Multi-Response Surface in Machining Process

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Multi response surface methodology uses mathematical and statistical techniques for analysis and modelling of the optimization problems for the responses which are affected by multiple factors. Multi-response surface methodology is commonly used in the new product formulation, improvement of the current products’ designs, process optimization, process improvement and development. In this study, a multi-response surface methodology by applying fuzzy logic in machining process is presented. Fuzzy numbers are selected considering the variability in repeating experiments. Desirability function approach is used to convert different fuzzy response factors into a single factor. Finally, a fuzzy mathematical model is developed to optimize this single factor. The model has the flexibility to weight the response factors depending on the decision maker’s choices. The input variables are cutting speed, feed rate, and material thickness. The responses are surface roughness, axial and radial forces and chip type. The optimum factor levels for response surfaces are evaluated in the conclusion.
A Comparison among the Convergent, Cesàro Convergent and Riesz Convergent Sequences of Fuzzy Numbers

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Tripathy and Baruah presented the Nörlund and Riesz mean of sequences of fuzzy numbers in 2010. Afterwards, Talo and Çakan introduced the Cesàro summability of sequences of fuzzy numbers in 2012 and showed that if a sequence of fuzzy numbers is convergent then it is also Cesàro convergent but the converse is not true. In this paper, we have showed that if a sequence of fuzzy numbers is convergent then it is also Riesz convergent but the converse is not true. We also showed that if a sequence of fuzzy numbers is Riesz convergent then it is not necessary to be the Cesàro convergent.

Primary Fuzzy Ideals

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The aim of this paper is to introduce the fuzzy ideal expansion, a primary fuzzy ideal which unify prime fuzzy ideals and primary fuzzy ideals and to investigate some of their properties. A number of main results about prime fuzzy ideals and primary fuzzy ideals are extended into this general framework.

On the Solutions of Fractional Riccati Differential Equation with Fuzzy Initial Condition

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In this paper, we define a fractional Riccati differential equation with fuzzy initial conditions. An evolutionary algorithm is used to obtain the solutions of this fractional differential equation. Proposed method is based on the solutions of a set of corresponding fractional Riccati differential equations with crisp initial conditions by applying evolutionary algorithms. Accuracy of the proposed algorithm is studied from some examples.
Molodtsov proposed the soft set theory as a mathematical tool to deal with uncertainties. Vague set is a set of objects each of which has a grade of membership whose value is a continuous subinterval of [0,1]. This set is characterized by a truth-membership function and a false-membership function. Thus, a vague set is actually more accurate form of fuzzy set. Using the concept of vague soft sets, we are able to ascertain that the grade of membership of an element lies within a certain closed interval which can help to overcome the problems faced when using ordinary soft set or fuzzy soft sets. In this paper, using the gamma ring and vague soft set’s concepts which were introduced by Rosenfeld’s approach, vague soft gamma rings, vague soft gamma ideals of a gamma ring, the vague soft gamma ideal of a vague soft gamma ring, idealistic vague soft gamma ring and vague soft gamma ring homomorphism are studied.
Determining Relative Efficiency of Turkish Provinces According to their Resource Utilization by Classic and Fuzzy Data Envelopment Analysis Methods

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Efficiency and productivity became critical concepts in manufacturing/ service sectors either it is private or public with globalization and increasing competition context. Data Envelopment Analysis (DEA) is one of the non-parametric efficiency measurement methods. In this research implementing of classic and fuzzy versions of Data Envelopment Analysis (DEA) and then comparing the obtained results are aimed. For this purpose, resource utilizations of 77 provinces located in Turkey are evaluated by *Classic Input Oriented CCR* and *Fuzzy Input Oriented CCR with Interval Numbers* models in terms of competitiveness. Aydemir (2002) used *Classic Input Oriented CCR* with Frontier Analyst software. In this research, to compare classic/fuzzy models and different software Aydemir’s (2002) data solved with *EMS 1.3* package software. The efficiency and the density scores related to each province are determined. Efficient and inefficient provinces are determined from software results. The target scores and improvement ratios are calculated in terms of Eskisehir, which is an inefficient city in both models. Finally, resource utilizations and input excesses are evaluated. According to Classic Data Envelopment Analysis, 39 of 77 provinces are found on the efficiency frontier. In the Fuzzy Data Envelopment Analysis, number of provinces on the efficiency frontier decreased to 25. This result shows that the evaluation made with considering the errors in data is more realistic.

A Multiple Criteria Decision Making Method on Single Valued Trapezoidal Neutrosophic Numbers Based on Einstein Operations

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Multiple criteria decision making (MCDM) is one of the most important problem in the decision making sciences with single valued trapezoidal neutrosophic information. Therefore, the aim of this paper to investigate a MCDM method under single valued trapezoidal neutrosophic (SVTN) environment. To construct this method, we first introduce some Einstein operational laws on SVTN-numbers based on Einstein sum and Einstein product. Then, some SVTN arithmetic and geometric operators based on Einstein operations are proposed. Finally, we develop an MCDM method and apply to an MCDM problem by using the operators in which decision information takes the form of SVTN numbers.
A Decision Making Method by Combining TOPSIS and Grey Relation Method under Fuzzy Soft Sets

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In this study, we first introduce the fuzzy sets, soft sets, fuzzy soft sets and their related properties. We then present the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) that is one of classical Multiple Attribute Decision Making (MADM) methods. We also present the Grey Relation Method. In the main part of this study, we extend the TOPSIS method on the fuzzy soft set theory to construct a decision making method to deal with problems that contain uncertainties. To make it we combine the TOPSIS and The Grey Relational Analysis (GRA) under fuzzy soft sets. We finally give an illustrative application for drug selection.

A comparison of integration of Geographic Information Systems with Fuzzy AHP and Fuzzy TOPSIS in Location Analysis

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Location analysis is a sophisticated research area that is affected by various factors. Due to its complexity, wide-range solution approaches are applied in the literature to overcome the complexity and reach the decision. Multi-criteria decision analyses are frequently used solutions. However, these approaches are reaching the results based on the experts’ subjective and arguable thoughts. On the other hand, there are different approaches based on Geographic Information Systems (GIS), which is capable of dealing with vector data to produce exact information on the spatial parameters, instead of subjective expressions. These approaches suggested using GIS where a spatial decision criterion is considered to eliminate subjectiveness. Within the study, a comparison is done for the integrations of the GIS with Fuzzy Analytic Hierarchy Process (f-AHP) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (f-TOPSIS) methods. For that aim, a case study is done and the results have shown the integration of GIS and the multi-criteria approaches gives reasonable results in location analysis and these integrations are more reliable then solely usage of the multi-criteria approaches. However, there are some differences detected in the results and these are given and discussed in the paper.
Expected Value of SV-Trapezoidal Neutrosophic Numbers and its Applications to Multi-Attribute Decision Making Problems

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In this paper, we propose a novel concept of expected values for single valued trapezoidal neutrosophic numbers to handle single valued trapezoidal neutrosophic multi-attribute decision-making problems. Then, we develop a multi-attribute decision-making method in which decision information takes the form of single valued trapezoidal neutrosophic numbers. In this method, the decision information of an alternative on attribute and the weight values of attribute take the form of single valued trapezoidal neutrosophic numbers for ranking alternatives and the most desirable one(s) can be selected according to the expected values. Finally, a numerical example is given to demonstrate how to apply the proposed method and verify the feasibility and effectiveness of the developed method.

Cloud Computing Technology Selection with Integrated Intuitionistic Fuzzy Multi Criteria Decision Making Method

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Cloud computing technology (CCT) aims to deliver a network of virtual services so that users can access them from anywhere in the world on subscription at competitive costs. It also offers significant benefits to the businesses and communities by freeing them from the low-level task of setting up Information Technology infrastructure and thus creating business value for their services. For this reason, the objectives of this study are to identify important decision criteria and sub criteria that are relevant to the CCT selection problem; to provide an effective integrated framework to evaluate and select the most appropriate CCT and to apply proposed approach through a motivated application. The nature of technology selection is a complex multi criteria problem including both quantitative and qualitative factors which may be in conflict and may also be uncertain. An intuitionistic fuzzy (IF) set is a powerful method to cope with uncertainty by taking both degree of membership and non-membership function. Therefore, this paper proposes the integration of intuitionistic fuzzy preference relation aiming to obtain weights of criteria and intuitionistic fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method aiming to rank alternatives for dealing with imprecise information on selecting the most desirable CCT. To illustrate the application of the proposed method, a case study is also given.
Weighting the Criteria of Calibration Supplier Selection Problem with Fuzzy AHP in a Group Decision

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Although supplier selection problems are studied mostly in literature, calibration supplier selection problem is rarely studied. Determining the criteria of calibration supplier selection problem can be defined as a Multi-Criteria Decision Making Problem. Some criteria can be a prerequisite for making calibration. But it is necessary to weigh of the other criteria for selecting calibration supplier. In this study, complaint policy, performance history, cost, communication with customer, delivery on time, location, quality of calibration service and etc. are determined as a criteria of the calibration supplier problem. These criteria are considered by using fuzzy AHP (Analytic Hierarchical Process) in a hierarchically group decision.

Selection of the Best Third-Party Logistics (3PL) Company with Fuzzy Analytic Network Process (FANP)

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Decision making is important both the people and companies. So the multi-criteria decision making process easier methods have been developed for decision makers. Companies transfer their logistics activities to another company who are experts in logistics for reducing costs, quality development and providing a competitive advantage. This event is called the third-party logistics (3PL). Companies must be able to effectively use multi-criteria decision making method for compare firms, making right decision and preventing financial losses. In this paper, Analytic Network Process (ANP) method which is one of the multi-criteria decision making methods and to handle interaction among the criteria is introduced. Expert opinion is very important in this method. But, giving verbal expression to their views on a topic of experts will be more accurate than the use of the exact number. Due to being of the criteria are qualitative, interaction among the criteria and variables are linguistic, Analytic Network Process method and Fuzzy Logic methods in an integrated Fuzzy Analytic Network Process (FANP) method has been developed. The base of FANP method eliminates uncertainty in the feelings of people, ideas and prejudices. In this paper, in appropriate with the FANP method, a multi-criteria decision problem was discussed under the benefits, opportunities, costs and risks (BOCR) criteria about selection of the best third-party logistics company.
ERP Software Selection for a Company with Fuzzy Analytic Hierarchy Process (FAHP) Method

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In recent years, software selection is decision problem gained importance with companies are moving toward the use of information technology. A combination of many factors should be considered and multi criteria decision structure occurs in the software selection. Enterprise Resource Planning (ERP) makes possible an integrated enterprise system to automate the flow of information, material and financial resources among all functions within an enterprise on a common database. To successfully implement an ERP project, it is a necessity to determine the proper software compatible with the structure of the company. Otherwise; it causes a great amount of loss of funds and time in companies. Also it causes a disruption of activities. In this study, ERP software selection (ABAS, MS AX, QAD, and SAP) is made with Fuzzy Analytic Hierarchy Process method of multi criteria decision making methods in a company engaged in manufacturing. Multi criteria structure is combined fuzzy logic due to the need for some linguistic criteria and managers are aimed to provide decision support in study.

Using Fuzzy AHP and Conjoint Analysis to Identify Importance Degrees of Parameters on Academic Performance

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There are many parameters related to academic performance such as project study, thesis advisory, academic publication (article, proceedings, and book), design, and patent, etc. These parameters have different importance degrees on academic field. For this purpose, in this study, fuzzy analytic hierarchy process (FAHP) and conjoint analysis are used to determine importance degrees of these parameters. FAHP, one of the most used multiple criteria decision making techniques, is based on pairwise comparisons whereas conjoint analysis is a statistical technique used to analyze marketing trend to determine importance of different attributes. In this study, outcomes obtained from these techniques are compared.
The Evaluated Shopping Mall Locations Based on Fuzzy AHP Integrated Fuzzy VIKOR

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Fuzzy sets theory allows developing models which contain the complexity in real life situations and also allows the usage of linguistic variables. While making decisions which contain more than one alternative and criterion, the quantitative methods are required to be used in which the complexity and uncertainty should be taken into account. Due to the complexity and uncertainty of real life decisions, these classical or crisp techniques may be inadequate. In order to overcome this, fuzzy extensions of these methods were developed to better represent the uncertainty. In this study, shopping mall location selection problem is handled and the appropriateness of alternative shopping mall locations is analyzed. Fuzzy AHP integrated fuzzy VIKOR which can be named as fuzzy hierarchical VIKOR method is applied for the evaluation of alternative locations.

A Fuzzy Multi Criteria Decision Approach for Evaluating Renewable Energy Sources

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Energy is one of the most important resources for life, and energy resources and energy production have a great importance for both countries and economies. Selecting the suitable and efficient energy resource and energy production method are also crucial within the energy production process. While producing the suitable and efficient energy, potential damages to the environment and the ecological system also have to be taken into consideration. Non-renewable energy sources (NES) have a great impact on the environment and the ecological system. Besides, NES are running out day by day and detriments of NES in the long run will be evident if they are considered with a comprehensive perspective. On the other hand, renewable energy sources (RES) have less impact on the environment and the ecological system without any risk about their extinction. Advantages and disadvantages of RES depend on circumstances. In this study, we aim to analyze the advantages and disadvantages of RES with subjective perspectives using linguistic scales. To this end, fuzzy VIKOR which is a fuzzy multi-criteria decision making approach is proposed and used to evaluate RES.
Fuzzy Real Option Valuation in a Solar Investment Project

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Today, financial decision makers seek new models to avoid some inadequacies of conventional methods to value investment projects. Classic real option valuation methods propose solutions to two basic problems which conventional methods cannot response: project valuation under uncertainty because of cash flows and managerial flexibilities like postponement, growth, enlargement, abandonment. Usage of fuzzy numbers in a real option valuation method which is suggested by Carlsson and Fuller give opportunity to decision maker to extend scope of uncertainty with possibilistic approximation. In this study, a solar energy investment, which is rejected with fuzzy net cash flow analysis, is valued by fuzzy real option valuation methods to decide under uncertainty. Moreover, postponement decision is examined to invest in the most profitable year. Finally, historical volatility is used as a variance variable in fuzzy real option valuation in addition to variance of fuzzy numbers.

Modeling Uncertainty in Operators’ Statements in Measuring the Performance of a Continuous Production Line

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In the global and highly competitive business environment, all firms should improve their performance continuously. Yet, performance of many manufacturing companies heavily depends on the performance of their production equipment. In order to improve their equipment’s performance, firms should properly define, measure, analyze and eliminate all the activities, which do not add a value to their products, namely the production losses. In this study, a continuous production line for PVC extrusion is considered. Production rates and stoppage durations are recorded based on the operator’s statements. Due to uncertainties, these values are converted into triangular fuzzy numbers. The left and right spreads of triangular fuzzy numbers are calculated by considering production balance equations. Based on fuzzy stoppage durations and production rates, fuzzy production losses are calculated by using fuzzy arithmetic. Fuzzy results are then compared with the crisp results, which are calculated by considering operators’ statements as crisp, and the actual values gathered from the production data. As a result, it is concluded that fuzzy production loss values are notably closer to actual values in comparison to the crisp ones. With this study, the aim is to handle the uncertainty due to unreliable measurements in the data, caused by operators in calculating performance measures, and to help managers to
measure non-value added activities more accurately for better decisions on improvement areas related to production and production equipment.

**Integrated Fuzzy Monte Carlo Simulation Model and Branch and Bound Algorithm for Solving Scheduling in Filling Process**

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The fuzzy modeling is the proper approach to solve any problem involving vague and imprecise parameters such as costs, process times, demand etc.. In this study, the problem of scheduling of a filling, capping and labeling line in a beverage manufacturer is addressed. There are two essential performance measures for determining a good schedule for the planning department. These measures are the efficiency of the filling line which is negatively affected by the increase in setup times and service levels of the products filled in the line. Different types of setups and changeovers between products exist in filling lines. These setups and changeovers vary with respect to label, bottle, cap and concentration of products. Some of the setup and changeover times are sequence dependent. The most suitable example of sequence dependent setup time in the beverage industry is the duration for cleaning filling line when the concentration of product is changed which is called sanitation time. The study proposes a heuristic approach which integrates a branch and bound algorithm and a fuzzy Monte Carlo simulation modeling. A numerical study is also provided to illustrate the implementation of the proposed approach.

**Statistical Arbitrage with Fuzzy Logic A Financial Application**

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Financial pricing and prediction of stock markets is a specific and relatively narrow field, which have been mainly explored by mathematicians, economists and financial engineers. Prediction with the purpose of making profits in a domain constructed of random walk series, which are martingale, is a hard task. Pairs trading strategy attempts to resolve the drawback of unpredictability using relative pricing idea. This is, if two securities have similar characteristics, prices should also be similar. Deviation from the acceptable similarity range in the prices is considered as an anomaly, and whenever the anomaly is noticed, pair trading is executed regarding the anomaly will correct itself. Actors of the equities markets need to make fast and effective decisions in a very narrow, stressful time frame and in a domain with high-volume information flow. As the new strategies developed by these actors increase in terms of quality as well as quantity, the market efficiency increases, which causes the arbitrage opportunities to diminish. Today’s high tech markets letting ultra-high speed algorithmic trading systems inference, makes markets highly efficient and even harder to forecast. The fact that studies on algorithmic trading strategies,
attempting to determine the optimal time for an order, are based on strict mathematical rules, these strategies weaken over time in terms of arbitrage. In this study, we propose a new strategy employing fuzzy logic, for the trading decision-making in pairs trading strategy, as the domain of fuzzy logic lets us to mimic human decision-making and take advantage of arbitrage opportunities that the crisp mathematical models may miss to acquire.

On Solving Transportation Problems with Interval-Valued Trapezoidal Fuzzy Numbers

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In traditional transportation problem (TP) it is assumed that the decision maker has exact information about the coefficients belonging to the problem. In real world cases, values of transportation cost, supply and demand of the product may not be known precisely due to uncontrollable factors. The aim of this article is to introduce a new formulation of TP involving interval-valued trapezoidal fuzzy numbers for the transportation costs and crisp values of supplies and demands. The ordering of interval-valued trapezoidal fuzzy numbers by the help of sigh distance ranking is utilized to develop a method for finding an initial basic solution. The same ordering is applied to develop interval-valued fuzzy dual multipliers method for finding the optimal solution in terms of interval-valued trapezoidal fuzzy numbers. The proposed approach is illustrated by a numerical example.
A Systematic Type-2 Fuzzy Modelling Methodology for Time Series Forecasting

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In this paper, a systematic approach for modelling time series using type-2 fuzzy sets is proposed. In many areas in economic, engineering, meteorology etc., modelling time series as process models, and using these models for forecasting are widely used. In traditional approach, the linear process models are used for time series modelling, nevertheless because of the uncertainty and nonlinear characteristics of the time series data, these linear models cannot represent characteristics of time series properly. Even though, in the literature many successful time series modelling methodologies using fuzzy sets are presented to overcome these problems, recent works show that the conventional type-1 fuzzy sets cannot always handle the uncertainty successfully. Therefore, type-2 fuzzy modelling approaches are presented for time series within the last decade. In the proposed methodology, firstly the times series data is decomposed then the type-2 fuzzy modelling approach is applied on the residual part. To determine the type-2 fuzzy model parameters, Big Bang - Big Crunch optimization method is used because of its fast convergence property. In the experimental study show that the proposed type-2 fuzzy demand forecasting model is outperformed the other conventional models, and the proposed new approach is an effective and feasible for time series forecasting.

Strategy Selection via Hierarchical Type-2 Fuzzy “TOPSIS-DEMATEL” Approach

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In this study, a new interval type-2 fuzzy Multiple-Attribute Decision Making (MADM) model is developed by integrating Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Decision Making Trial and Evaluation Laboratory (DEMATEL). The proposed model utilizes hierarchical decomposition approach for reducing inherent complexity of the decision making problems. Additionally, interdependencies among problem attributes are taken into consideration by using interval type-2 fuzzy DEMATEL method. Finally, ranking orders of the alternatives are obtained by hierarchical interval type-2 fuzzy TOPSIS method. The proposed model is implemented in a Strengths, Weaknesses, Opportunities, and Threats (SWOT)-based strategy selection problem.
Passenger satisfaction evaluation and improvement are one of the most important operations for public transportation service provider. For this purpose, Istanbul Public Transportation Co., the only rail transit service provider of the Istanbul, applied a survey to question the satisfaction of the passengers with respect to rail transit lines considering multi criteria in 2012. A total of 4966 passenger survey is conducted in five rail transit lines. In this paper, TOPSIS approach based on interval type-2 fuzzy sets is applied to evaluate the passenger satisfaction level for five rail transit lines in Istanbul. Twenty six service qualities for passenger satisfaction are considered.

Fuzzy Modeling for Replicated Response Measures by Using Type-2 Fuzzy Numbers

Modeling is one of the main stages in response surface studies. Even the statistical regression analysis is a common tool to model this kind of problem, the assumptions on the data cannot be satisfied for some cases as well as the validity of estimated model. In these cases, fuzzy modeling provides more proper approaches to model unknown response. In this study, to represent the replicated response measures and unknown model parameters, type-2 fuzzy numbers are used, and then the fuzzy model parameters are estimated by using the fuzzy least square method. In the application, a benchmark data set is preferred to make an accurate comparison with classical approaches in terms of estimation results. According to analysis results, the proposed fuzzy model with type-2 fuzzy numbers has smaller modeling error than the fuzzy model with type-1 fuzzy numbers.
An interval type-2 fuzzy approach for evaluating humanitarian relief logistics performances of non-governmental organizations

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Non-governmental organizations play a vital role in preparedness and response to natural disasters. The aim of the non-governmental organizations is to minimize the losses and number of affected people. Hence, the performance of humanitarian relief non-governmental organizations is becoming a key factor to support governmental relief activities. In this paper, an integrated Analytic Hierarchy Process (AHP) and Elimination et choix traduisant la réalité (ELECTRE) approach based on interval type-2 fuzzy sets (IT2FSs) approach is proposed for evaluating humanitarian relief logistics performance of non-governmental organizations (NGOs). The proposed integrated approach is applied for non-governmental organizations in Turkey to evaluate their performances.
Project management in healthcare: A case for evaluating patient flow of an emergency room with fuzzy CPM and fuzzy PERT

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An ideal healthcare system is considered as a system that provides the most quality service level, lower costs and unlimited access. Any delay in patient flow may result in undesired consequences and losses in healthcare facilities such as hospitals and their sub units. Project management is defined as application of techniques to project activities to meet the project requirements. It has techniques that can help healthcare facilities and units standardize care and quality, reduce costs, improve effectiveness and decrease prolonged waits. The current study is carried out in an emergency department of a university hospital to understand the patient flow of the department with respect to the Fuzzy Critical Path Method (FCPM) and Fuzzy Program Evaluation Review Technique (FPERT). The reason for incorporating fuzzy sets is stemmed from that fuzzy numbers are more effective for high uncertainty processes as in emergency departments. Activities affecting patient flow through the ED are identified and project network is drawn. 1500 patients’ data about the times of each activities are obtained from the observed ED. Findings through application of FCPM and FPERT, the expected time for completion of the project, the critical path and slack times are determined.

Analysis of Performance Indicators Using Fuzzy Multi-Criteria Decision Making Approach in Healthcare Management

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This study aims to analyze the performance indicators of service in a research hospital by using an integrated multi-criteria decision making approach. The proposed method integrates the Fuzzy Analytical Network Process (FANP) and Fuzzy Decision Making Trial and Evaluation Laboratory (Fuzzy DEMATEL) approaches to evaluate and rank alternative healthcare organizations in terms of defined performance criteria. It is a novel approach to implement fuzzy DEMATEL technique with trapezoidal fuzzy numbers as well as adapting CFCS defuzzification method for trapezoidal fuzzy numbers. In this paper, a decision model is developed to analyze indicators affecting patient and employee satisfaction, efficiency, effectiveness of healthcare management at the research hospital. Thus, this study provides to answer fundamental research questions are “how can it be defined the weights of the indicators affecting the performance of Healthcare Management (HM)?” and “what are the relationships between the performance indicators and the criteria affecting the performance in HM?” This study put forward the quantitative relative weights analyzing
the performance indicator and the criteria and also will lead to the development of a performance model measuring doctors’, clinics’ and hospitals general performance using the indicators in HM.

An Integrated AHP and Fuzzy MOORA Methodology for Medical Company Selection in Health Sector

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The correct choice of the devices used in the health sector is great importance for reduction of the workforce, improving quality and saving time. Therefore, selection of medical company that devices will be provided is an important decision problem. In this study, AHP and fuzzy MOORA methods were utilized for selection of DNA-RNA-protein isolation device which will be used in a laboratory that conducts scientific research in the Atatürk University Faculty of Medicine. As a result of surveys conducted by responsible experts for the medical selection, 7 criteria established and pairwise comparison matrix has been established. Then, weights of criteria determined by analytic hierarchy process (AHP) and 4 different alternative were listed by fuzzy Multi-Objective Optimization by Ratio Analysis (MOORA).

Fuzzy MCDM Usage in Healthcare Service Quality Literature

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Service quality is a phenomenon that is generally evaluated by customer’s perception. SERVQUAL is the dominant measurement tool in this area. Because of the distinctive properties of services, service quality is highly affected by subjective judgments which tend to be vague and imprecise in uncertain environments. From this view, researchers started to use fuzzy logic in service quality. The purpose of this paper is to review the fuzzy multi criteria decision making (MCDM) usage in healthcare service quality. “Web of Science” and “Science Direct” databases were searched with the keywords “fuzzy” and “health service quality”. After the investigation of the papers, there has been found only 5 papers. The researchers are from Turkey and Taiwan. The papers dates are in 2006-2014 range. Fuzzy TOPSIS, fuzzy VIKOR and hybrid MCDM techniques are used. AHP is used with TOPSIS, OWA, and PROMETHEE in all hybrid techniques. The results show that there is an opportunity to use other fuzzy MCDM techniques (DEMATEL, ELECTRE etc.) in healthcare service quality. ANP is an alternative technique that can be used in hybrid techniques.
Effect of Rule Evaluation in Hierarchical Systems: A Benchmark on XOR Gate

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Hierarchical Fuzzy Systems are proposed to overcome the curse of dimensionality problem occurred while using single fuzzy systems with a large number of input parameters. In hierarchical systems, lower dimensional subsystems are connected in a hierarchical manner to solve a high dimensional problem. The hierarchic structure is varied according to these connections such as aggregated, incremental and cascaded. Just like the Mamdani style single fuzzy system, a hierarchical system’s output is affected from both the utilized rule evaluation and the defuzzification methods. This effect can be easily observed in behavior of hierarchical fuzzy systems because each variation of the systems’ modelling causes differentiation on the systems’ output. In this paper the effects of using different rule evaluation methods in Mamdani style inference is investigated. Experiments are performed on logical XOR gate by utilizing two rule evaluation pairs as minimum-maximum and product-sum. Center of area, bisector of area and weighted average defuzzifiers are also considered respectively. The chosen hierarchic structures are aggregated and incremental. The accuracy is measured by taking the Root Mean Square Error and Coefficient of Determination values into account based on the single system’s output. Results show that more consistent outputs are achieved by minimum-maximum then product-sum for the chosen problem. In detail, minimum-maximum based evaluation provides the closest outputs to the single system regardless of the used defuzzifier in aggregated structure. However a strict pattern cannot be observed on incremental structure even though the minimum-maximum evaluation is still more consistent.
A Bibliometric Analysis of Research Related to Fuzzy Association Rules

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Fuzzy association rules, being one of the main data-mining methods, have found a growing use in the literature. It basically finds “association(s) among items” for the system under fuzziness. In this study, a bibliometric analysis is conducted to explore the literature related to fuzzy association rules and their use. The papers published in well-respected journals and presented in conferences are considered for the analysis. Number of articles by year, publication activity of countries, and leading journals are highlighted and presented in this study. Future research directions are also provided for potential readers.

Linguistic Summarization of Restaurant Evaluation Data Set Using Type-I and Type-II Fuzzy Quantified Sentences

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As Internet applications, such as blogging, review sites, social applications, are becoming more and more popular the amount of information is increasing. Also, the number of evaluations and reviews are increasing rapidly. Therefore, it is difficult to distinguish non-useful reviews from useful ones. Linguistic summarization is an emerging technology. It summarizes numerical and textual data in understandable short format. In this study, linguistic summarization of restaurants data is obtained automatically. The system provides understandable summary of the reviews with fuzzy set theory.

Fuzzy version of the Jalan-Ravallion’s approach: evidence from Tunisia

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This paper offers a new methodology to analyze poverty dynamics components. We have made available a new replay to the traditional Jalan-Ravallion approach using fuzzy measures. We propose new measures for chronic, transient and persistent poverty. Therefore, we compute observed poverty for each attribute. Our methodology is based on the proposal for a rule base, the choice of individual and aggregate membership functions, and the choice of fuzzy rules defining the intersection, union and negation for manipulating the fuzzy sets results. Finally, we present an application to the dynamics welfare assessment in Tunisia from 2005 to 2010.
Handling Uncertainties in the connection of PHEVs to Smart Grid Using Fuzzy Logic

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The use of plug in hybrid electrical vehicles (PHEVs) in smart grids is one of the hot issues in energy sector. In the connection of PHEVs to grid, several issues such as: controlling the charge and discharge of the battery, estimation charge and discharge level of battery, managing data communication between the vehicles and aggregators, financial settlement with actors, and handling uncertainties must be considered. This paper focuses on the uncertainties exist in the connection of PHEVs to smart grid. Four types of uncertainties will be considered, and their appropriate way of handling will be explained. Fuzzy logic theory is used to handle the uncertainties. The effectiveness of the proposed approach will be shown for a number of grid scenarios.

A Hough Transform based on the Map-Reduce Algorithm

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This paper presents a method that proposes the composition of the Map-Reduce algorithm and the Hough Transform method to research particular features of shape in the Big Data of images. We introduce the first formal translation of the Hough Transform method into the Map-Reduce pattern. The Hough transform is applied to one image or to several images in parallel. The context of the application of this method concerns Big Data that requires Map-Reduce functions to improve the processing time and the need of object detection in noisy pictures with the Hough Transform method.
Fuzzy Based Flux Oriented Direct Torque Control of Induction Motor

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Direct torque control method (DTC) is a vector control system. It allows calculating motor’s flux and torque with the help of measurable magnitudes by motor parameters. The method is based on applying a switching series from a switching table, which shall directly eliminate errors, which shall occur in torque, through the reference given as value and the calculated flux, to the power switching elements in the inverter. However, each vector selected from the switching table cannot produce the required accurate stator voltage vector to provide the desired torque and flux. This results in the production of ripples in the torque as well as flux waveforms. In this study, we propose a method to reduce torque fluctuations. In this method, Active voltage vectors are selected from the switching table according to Torque and Flux error of hysteresis outputs. Afterwards, Fuzzy logic controller employs the magnitude of flux linkage and the error in magnitude of flux linkage as the inputs. And Fuzzy controller selected the optimum timing pairs. These timing pairs are time of the applied active vectors to the outputs. This method is compared to conventional DTC method. The conventional DTC and the fuzzy based flux linkage error oriented DTC method are simulated and the comparison of their performances are presented.

Comparative Analysis of Performance of Fuzzy and Intuitionistic Fuzzy Similarity Measures on Noise Added Images

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In this study, we investigated the performance of several similarity measures defined on fuzzy and intuitionistic fuzzy which used widely in theory and applications. We tested these measures with three type noises (salt and pepper, Gaussian, Speckle) with different levels and we gave experimental results obtained from these processes.
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