Systems Research Institute
Polish Academy of Sciences

Newelska 6, 01-447 Warszawa, Poland

Phone: (48) 22 38 10 100
Directors: (48) 22 38 10 275
Fax: (48) 22 38 10 105
E-mail: ibs@ibspan.waw.pl
Web: www.ibspan.waw.pl
Tax no.: 525 000 86 08

Professor Janusz Kacprzyk, Ph.D., D.Sc., Dr. h.c. (mult.)
Fellow of IEEE, IFSA, EurAI/ECCAI, SMIA
Full Member, Polish Academy of Sciences
Member, Academia Europaea (Informatics)
Member, European Academy of Sciences and Arts
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Warsaw, August 31, 2017

To whom it may concern

As a member of the Editorial Board of the Journal of Multivalued Logic and Soft Computing. http://www.oldcitypublishing.com/journals/mvlsc-home/, published by Old City Publishing, who is responsible for the processing, notably the review and acceptance process of the papers, I wish to reconfirm that the paper:

"Intercriteria analysis of The Global Competitiveness Report: from efficiency- to innovation-driven economies"
Vassia Atanassova, Lyubka Doukovska, Aleksander Kacprzyk, Evdokia Sotirova, Irina Radeva, Peter Vassilev

has been subjected to a peer review process, has received positive reviews and has been accepted for publication. It should appear in the first half of 2018 due to a very high submission flow of papers to our Journal.

The Journal of Multivalued Logic and Soft Computing is indexed on the ISI/Thomson WoS JCR list and has the impact factor of IF = 0.667.

Best regards.
Sincerely yours,

J. Kacprzyk

InterCriteria analysis of the Global Competitiveness Reports: from efficiency- to innovation-driven economies

Vassia Atanassova[1], Lyubka Doukovska[2], Aleksander Kacprzyk[3], Evdokia Sotirova[4], Irina Radeva[2], Peter Vassilev[1]

[1] Bioinformatics and Mathematical Modelling Department
Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences
Acad. G. Bonchev str., bl. 105, 1113 Sofia, Bulgaria
e-mail: vassia.atanassova@gmail.com; peter.vassilev@gmail.com

[2] Intelligent Systems Department
Institute of Information and Communication Technologies, Bulgarian Academy of Sciences
Acad. G. Bonchev str., bl. 2, 1113 Sofia, Bulgaria
e-mails: doukovska@iit.bas.bg; iradeva@iit.bas.bg

[3] Resource Partners Sp. z o.o.
Zebra Tower, 1 Mokotowska str., 00-640 Warszawa, Poland
e-mail: aleksander.kacprzyk@resourcepartners.eu

[4] Intelligent Systems Laboratory, Prof. Dr. Asen Zlatarov University
1 Prof. Yakimov Blvd., 8010 Burgas, Bulgaria
e-mail: esotirova@btu.bg

Abstract: Intercriteria analysis is applied here to data retrieved from the World Economic Forum's Global Competitiveness Reports from 2013–2014 to 2017–2018 about the set of countries in the world, which stage of economic development is in the transition from efficiency-driven to innovation-driven. We analyse data in search of correlations between the twelve pillars of competitiveness across, we outline and comment the findings, comparing them with results from our previous research performed over the member states of the European Union. What is specific in the application of ICA here is that we work with a set of elements (countries), whose belongingness to the set depends on their performance according to the set of criteria, and the set of objects varies over the years, although there are some core countries that regularly appear in the set. This however gives rise to a discussion about the comparability of the ICA results, and sheds light on both the method and the analysed set of countries.

Keywords: Intercriteria analysis, Intuitionistic fuzzy sets, Correlation, Competitiveness, Global competitiveness report, Efficiency-driven economy, Innovation-driven economy, World Economic Forum.

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SCIENCES ET INGENIERIE

Intelligence artificielle

AN APPROACH TO A CONSTRUCTIVE SIMPLIFICATION OF MULTIAGENT MULTICRITERIA DECISION MAKING PROBLEMS VIA INTERCRITERIA ANALYSIS

Krassimir Atanassov, Eulalia Szmidt*, Janusz Kacprzyk*, Vassia Atanassova

(*Submitted on May 11, 2017*)

Abstract

A new multiagent multicriteria decision making procedure is proposed that considerably extends the existing methods by making it possible to intelligently reduce the set of criteria to be accounted for. The method employs elements of the novel Intercriteria Analysis method. The use of new tools, notably the intuitionistic fuzzy pairs and intuitionistic fuzzy index matrices provides additional information about the problem, addressed in the decision making procedure.

Key words: decision making, multiagent systems, multicriteria decision making, intercriteria analysis, intuitionistic fuzzy estimation

2000 Mathematics Subject Classification: 03E72

1. Introduction. Multiagent (group) multicriteria decision making problems are crucial for solving many, if not all, nontrivial real world problems, notably in settings which involve various economic, social, technological, etc. aspects. Yet they are very difficult to solve (cf. [19]). For an effective and efficient solution, one should use tools and techniques from various fields of science though it is more and more obvious that the use of formal (notably mathematical) methods is the proper solution (cf. [9]). However, the use of formal procedures which are based on a strict mathematical, logical, statistical, etc. reasoning and calculi is often too complicated which may be caused by both too high a number of agents and

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Intercriteria analysis of calorimetric data of blood serum proteome

Sashka Krumova [a], Svetla Todinova [a], Deyan Mavrov [b], Pencho Marinov [c], Vassia Atanassova [a], Krassimir Atanassov [a], Stefka G. Taneva [a,*]

[a] Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences, Acad. "G. Bonchev" Str. Bl. 21 and Bl. 105, 1113 Sofia, Bulgaria
[b] Computer Systems and Technologies Department, "Prof. Dr. Asen Zlatarov" University, 1 "Prof. Yakimov" Blvd., 8010 Burgas, Bulgaria
[c] Institute of Information and Communication Technologies, Acad. G. Bonchev Str., Bl. 25A, 1113 Sofia, Bulgaria

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ABSTRACT

Background: Biological microcalorimetry has entered into a phase where its potential for disease diagnostics is readily recognized. A wide variety of oncological and immunological disorders have been characterized by differential scanning calorimetry (DSC) and characteristic thermodynamic profiles were reported. Now the challenge before DSC is not the experimental data collection but the development of analysis protocols for reliable data stratification/classification and discrimination of disease specific features (calorimetric markers).
Methods: In this work we apply InterCriteria Analysis (ICA) approach combined with Pearson's and Spearman's correlation analysis to a large dataset of calorimetric and biochemical parameters derived for the serum proteome of patients diagnosed with multiple myeloma (MM).
Results: We have identified intercriteria dependences that are general for the various types of MM and thus can be regarded as a characteristic of this largely heterogeneous disease: strong contribution of the monoclonal (M) protein concentration to the excess heat capacity of the immunoglobulins-assigned thermal transition; shift of the albumin assigned calorimetric transition to allocation where it overlaps with the globulins assigned transition and strong shift of the globulins assigned transition temperature attributable to M proteins conformational changes.
Conclusions: Our data justify the applicability of ICA for deciphering of the complex thermodynamic behavior of the MM blood serum proteome.
General significance: The applied approach is suitable for more general application in the analysis of biocalorimetric data since it can help identify the biological relevance of the distinguished thermodynamic features observed for variety of diseases.

1. Introduction

The recent advances in the application of differential scanning calorimetry (DSC) in the studies of the thermally induced changes in the properties of the major plasma proteins in variety of diseases provide solid evidence for its strong potential for disease diagnostics and monitoring. In the last decade it became evident that the plasma/serum DSC profiles (thermograms) of disease individuals are affected not only by the disease-related protein concentration alterations but also by the emergence of new/modified molecular interactions and complexes formation. The complexity of the plasma/serum calorimetric profiles (hundreds of serum proteins giving rise to a multitude of overlapping calorimetric transitions) however obscures their straightforward interpretation. A major hurdle for the direct clinical application of DSC for disease diagnostics is the strict definition of disease-specific thermodynamic features that can only be obtained by the global analysis of extended arrays of data obtained for large variety of diseases. Multi-sample screening DSC instruments that are available nowadays allow for the generation of vast calorimetric databases for different diseases, however at present the development of analytical approaches that allow for the extraction of disease-specific thermodynamic markers characteristic for complex body fluids such as plasma and serum, the prediction of patients survival, and the monitoring of the effect of treatment from experimental databases are not yet fully elaborated. To this point three mathematical routines are introduced for in-depth analysis and stratification of serum/plasma calorimetric profiles: (i) algorithm based on similarity in shape and in distance of a test and a reference thermograms [9]; (ii) classification routine relaying on localized thermogram features and principal components [12] and (iii) thermograms deconvolution analysis for patients classification [24].

In this work, we deal with a database that contains calorimetric (thermodynamic parameters) and electrophoretic (protein concentrations of the major serum proteins) data recorded for 355 patients

* Corresponding author.
E-mail address: sgtaneva@gmail.com (S.G. Taneva).

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Research Article

Application of the Intuitionistic Fuzzy InterCriteria Analysis Method with Triples to a Neural Network Preprocessing Procedure

Sotir Sotirov,[1] Vassia Atanassova,[2] Evdokia Sotirova,[1] Lyubka Doukovska,[3] Veselina Bureva,[1] Deyan Mavrov,[1] and Jivko Tomov[1]

[1]*Laboratory of Intelligent Systems, University "Prof. Dr. Assen Zlatarov", 1 "Prof. Yakimov" Blvd., 8010 Burgas, Bulgaria*
[2]*Department of Bioinformatics and Mathematical Modelling, Institute of Biophysics and Biomedical Engineering, 105 "Acad. G. Bonchev" Str., 1113 Sofia, Bulgaria*
[3]*Department of Intelligent Systems, Institute of Information and Communication Technologies, 2 "Acad. G. Bonchev" Str., 1113 Sofia, Bulgaria*

Correspondence should be addressed to Sotir Sotirov; ssotirov@btu.bg

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The approach of InterCriteria Analysis (ICA) was applied for the aim of reducing the set of variables on the input of a neural network, taking into account the fact that their large number increases the number of neurons in the network, thus making them unusable for hardware implementation. Here, for the first time, with the help of the ICA method, correlations between triples of the input parameters for training of the neural networks were obtained. In this case, we use the approach of ICA for data preprocessing, which may yield reduction of the total time for training the neural networks, hence, the time for the network's processing of data and images.

1. Introduction

Working with neural networks presents many difficulties; for example, the number of neurons in the perception of the individual values can be too large, and since a proportionally larger amount of memory and computing power is necessary to train the networks, this would lead to a longer periods for training. Therefore, researchers are forced to look for better methods for training neural networks. Backpropagation is the most applied such method—in it neural networks are trained with uplink (applied on a Multilayer Perceptron). There are, however, many other methods that accelerate the training of neural networks [1–3], by reducing memory usage, which in turn lowers the needed amount of computing power.

In the stage of preprocessing, the data at the input of the neural network can be used as a constant threshold value to distinguish static from dynamic activities, as it was done in [4]. This way, the amount of incidental values due to unforeseen circumstances is reduced.

Another approach is to use a wavelet-based neural network classifier to reduce the power interference in the training of the neural network or randomly stumbled measurements [5]. Here the discrete wavelet transform (DWT) technique is integrated with the neural network to build a classifier.

Particle Swarm Optimization (PSO) is an established method for parameter optimization. It represents a population-based adaptive optimization technique that is influenced by several "strategy parameters." Choosing reasonable parameter values for PSO is crucial for its convergence behavior and depends on the optimization task. In [6] a method is presented for parameter metaoptimization based on PSO and it is applied to neural network training. The idea of Optimized Particle Swarm Optimization (OPSO) is to optimize the free parameters of PSO by having swarms within a swarm.

When working with neural networks it is essential to reduce the amount of neurons in the hidden layer, which

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Original Articles

Investigation of relationships between bulk properties and fraction properties of crude oils by application of the intercriteria analysis

Dicho S. Stratiev, Sotir Sotirov, Ivelina Shishkova, Angel Nedelchev, Ilshat Sharafutdinov, Anife Vely, Magdalena Mitkova, Dobromir Yordanov, Evdokia Sotirova, Vassia Atanassova, Krassimir Atanassov, Danail D. Stratiev, Nikolay Rudnev & Simeon Ribagin
...show less

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ABSTRACT

Data from assays of 244 crude oils (condensates, extra light, light, intermediate, and heavy crudes) were processed by the InterCriteria Analysis with the aim to investigate the relationships between bulk properties and fraction properties of the crude oils and the degree of similarity between them. It was found that except the crude bulk properties sulfur, Conradson carbon, and metals content all other studied crude bulk properties exhibited lack of statistically meaningful relations or presence of weak statistically meaningful relations with the crude fraction properties. The use of the InterCriteria Analysis showed that crudes with very similar properties could be identified when a large crude database is available. In this way based on a previous experience in oil refining a selection of potentially beneficial new crudes for processing in a refinery could be made.

KEYWORDS: Correlation; crude oil; crude selection; intercriteria analysis; oil properties

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MATHEMATIQUES
Informatique

INTUITIONISTIC FUZZY APPROACH TO THE PREFERENCE DEGREE ESTIMATIONS

Krassimir Atanassov, Eulalia Szmidt*, Janusz Kacprzyk*, Vassia Atanassova

(*Submitted on December 12, 2014*)

Abstract

The paper is dedicated to a new, intuitionistic fuzzy sets based approach in decision making procedures aimed at the estimation of the degrees of preference and non-preference, both in the [0, 1] interval, where a new degree of uncertainty also occurs as a complement of these two degrees to 1. The principal novelty of the approach is expressed in the opportunity not only to have various experts estimating various alternatives, but also to evaluate the experts as such, and iteratively use this information in subsequent procedures by calibrating the experts' evaluations with respect to demonstrated performance in their previous evaluations.

Key words: intuitionistic fuzzy estimation, preference degree
2010 Mathematics Subject Classification: 03E72

1. Introduction. This paper, by applying intuitionistic fuzzy approach, extends some formulas for estimation of preference degrees, proposed by Peneva and Popchev in their series of papers [5–9].

Let

$$E = \{E_1, E_2, \ldots, E_e\}$$

be a set of experts;

$$A = \{a_1, a_2, \ldots, a_n\}$$

be a set of alternatives, evaluated by the experts, who use the criteria

$$C = \{c_1, c_2, \ldots, c_m\}.$$

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Outline

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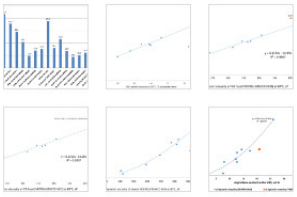
Figures (6)



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ELSEVIER

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Research article

Dependence of visbroken residue viscosity and vacuum residue conversion in a commercial visbreaker unit on feedstock quality

Dicho Stratiev [a], Angel Nedelchev [a], Ivelina Shishkova [a], Atanas Ivanov [a], Ilshat Sharafutdinov [a], Radoslava Nikolova [b], Magdalena Mitkova [b], Dobromir Yordanov [b], Nikolay Rudnev [c], Zlatozvet Belchev [b], Vassia Atanassova [d], Krassimir Atanassov [d]

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Highlights

- Visbreaker residue viscosity directly correlates with visbreaker VRO feedstock viscosity.
- Viscosity of VROs depends on maltene viscosity and quantity and quality of asphaltenes.
- Increasing of oil solubility power allows enhancing visbreaker feed conversion.

Abstract

Nine vacuum residual oils were characterized and eight blends of them were processed in the LUKOIL Neftohim Burgas commercial visbreaker unit. It was found that at constant content of about 8 vol.% of the fraction boiling up to 360 °C (diesel cut) in the visbroken residue the visbroken residue viscosity correlated with the vacuum residual oil visbreaker feed viscosity with a squared correlation coefficient $R^2 > 0.98$. By application of correlation analysis and intercriteria analysis the vacuum residual oil feedstock parameters which have statistically meaningful impact on conversion to product boiling below 360 °C were found to be vacuum residual oil sulfur and hydrogen content, and solubility power of maltenes. The results obtained in this work are consistent with those obtained from other groups, even for other types of vacuum residue processing like ebullated bed hydrocracking. The vacuum residual oils which contained more resinous-asphaltenic materials formed more asphaltenes in the process of thermal conversion. The vacuum residual oil viscosity increment with increasing of asphaltene content for the straight run vacuum residual oils can be described by a second order polynomial. The secondary vacuum residual oils — the visbroken vacuum residual oils exhibited a lower than straight run residual oil dependence of the residue viscosity increment on increasing of the asphaltene content.

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Abbreviations

AR, atmospheric residue; DAO, deaspalted oil; HCO, heavy cycle oil; HICO, heavy Iranian crude oil; FCC, fluid catalytic cracking; LNB, LUKOIL Neftohim Burgas; LP, linear programming; LHSV, liquid hourly space velocity; RPMS, refining and petrochemical modeling system; REBCO, Russian export blend crude oil; SARA, saturates, aromatics, resins and asphaltenes; VIS, viscosity; VGO, vacuum gas oil; VRO, vacuum residual oil; VBR, visbroken residue; VBVRO, visbroken vacuum residual oil (> 540 °C); VB, visbreaker; VBU, visbreaker unit

Keywords

Visbreaking; Thermal conversion; Vacuum residue; Viscosity; SARA; Asphaltenes

energy&fuels

Article

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Investigation of Relationships between Petroleum Properties and Their Impact on Crude Oil Compatibility

Dicho Stratiev*†, Ivelina Shishkova†, Angel Nedelchev†, Kiril Kirilov†, Ekaterina Nikolaychuk†, Atanas Ivanov†, Ilshat Sharafutdinov†, Anife Veli‡, Magdalena Mitkova‡, Tanya Tsaneva‡, Nedyalka Petkova§, Ron Sharpe§, Dobromir Yordanov‡, Zlatozvet Belchev‡, Svetoslav Nenov∥, Nikolay Rudnev⊥, Vassia Atanassova#, Evdokia Sotirova‡, Sotir Sotirov‡, and Krassimir Atanassov‡#

† LUKOIL Neftohim Burgas, 8104 Burgas, Bulgaria
‡ University Assen Zlatarov, 8010 Burgas, Bulgaria
§ Energy Services Division, Nalco Company, Naperville, Illinois 60563, United States
∥ University of Chemical Technology and Metallurgy, 1756 Sofia, Bulgaria
⊥ Ufa State Petroleum Technical University, Ufa, Russia 450080
Department of Bioinformatics and Mathematical Modelling, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences, 105 Academic Georgi Bontchev Street, 1113 Sofia, Bulgaria

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*E-mail: stratiev.dicho@neftochim.bg.

Abstract

Twenty-two crude oils around the world, from which 19 are processed in the LUKOIL Neftohim Burgas (LNB) refinery, were characterized in the LNB research laboratory by measuring 67 properties. These 22 crude oils included light low sulfur, light sulfur, intermediate low sulfur, intermediate sulfur, intermediate high sulfur, heavy high sulfur, and extra heavy extra high sulfur crudes. A new mathematical approach—the intercriteria analysis—was employed to study the relations between the petroleum properties. It was found that the petroleum properties, density, and sulfur content, along with the crude oil simulated distillation, seem to be capable of providing the same information as that from the full assay of a crude oil. Crude oils containing insoluble asphaltenes (self-incompatible oils) were found to have a high content of low aromaticity naphtha and kerosene. It was found that the asphaltene solubility correlated with the asphaltene hydrogen content. The oil solubility power was found to correlate with the oil saturate content. The oil colloidal stability seems to be controlled by the following rule: “like dissolves like”. The higher the aromaticity of the asphaltenes, the higher the aromaticity of the oil is required to keep the asphaltenes in solution. The processing of blends of oils which are incompatible or nearly incompatible may deteriorate the performance of the dewatering and desalting in the refinery, which consequently may damage the equipment due to accelerated corrosion, entailed by salt deposition. The processing of blends of oils, which are incompatible, not always can be related to an increased fouling.

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Intuitionistic Fuzzy Interpretations of Some Formulas for Estimation of Preference Degree

Krassimir T. Atanassov, Vassia Atanassova, Eulalia Szmidt and Janusz Kacprzyk

Abstract Two intuitionistic fuzzy interpretations of M. Fedrizzi, M. Fedrizzi and R. A. M. Pereira's, and of V. Peneva and I. Popchev's formulas are introduced and some of their properties are discussed.

1 Introduction

Already, there are a lot of research over procedures for obtaining of a consensus in group decision making. One of them—a fuzzy approach, is introduced by Mario Fedrizzi, Michele Fedrizzi, and R. A. Marques Pereira in [3]. Another approach is given by Vanja Peneva and Ivan Popchev in [4]. In [5], the authors introduced an extension of V. Peneva and I. Popchev's formulas, using intuitionistic fuzzy approach.

K.T. Atanassov (✉) · V. Atanassova
Department of Bioinformatics and Mathematical Modelling, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences,
105 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria
e-mail: krat@bas.bg

V. Atanassova
e-mail: vassia.atanassova@gmail.com

K.T. Atanassov
Intelligent Systems Laboratory, Prof. Asen Zlatarov University, 8010 Burgas, Bulgaria

E. Szmidt · J. Kacprzyk
Systems Research Institute, Polish Academy of Sciences,
ul. Newelska 6, 01-447 Warsaw, Poland
e-mail: szmidt@ibspan.waw.pl

E. Szmidt · J. Kacprzyk
WIT – Warsaw School of Information Technology,
ul. Newelska 6, 01-447 Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

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Intercriteria Analysis over Intuitionistic Fuzzy Data

Veselina Bureva[1], Evdokia Sotirova[1], Vassia Atanassova[2], Nora Angelova[2,3], and Krassimir Atanassov[1,2(✉)]

[1] Asen Zlatarov University — Burgas 1 "Prof. Yakimov" Blvd, 8010 Burgas, Bulgaria
{vbureva,esotirova}@btu.bg, deyanmegara@gmail.com
[2] Department of Bioinformatics and Mathematical Modelling, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences, 105 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria
vassia.atanassova@gmail.com, krat@bas.bg
[3] Faculty of Mathematics and Informatics, Sofia University "St. Climent Ochridski", 5, James Bourchier Str., 1126 Sofia, Bulgaria
metida.su@gmail.com

Abstract. The possibility for application of Intercriteria Analysis over intuitionistic fuzzy data is discussed. An example in the area of mathematical logic is given as an illustration of the application of the Intercriteria Analysis.

Keywords: Data · Intercriteria analysis
Intuitionistic fuzzy index matrix · Intuitionistic fuzzy pair

AMS Classification: 03E72

1 Introduction

The concept of InterCriteria Analysis was introduced in [4,7]. The intercriteria analysis is based on the apparatus of the Index Matrices (IMs, see [4]) and of Intuitionistic Fuzzy Sets (IFSs, see, e.g., [3]). The paper is a continuation of [1,6,7,9–11,14,15]. Here, for the first time we discuss the possibility, the data, that will be processed by intercriteria analysis, to be Intuitionistic Fuzzy Pairs (IFP, see [8]), variables or formulas, or more general - intuitionistic fuzzy data (see [12]).

2 Short Notes on Intuitionistic Fuzzy Pairs

The Intuitionistic Fuzzy Pair (IFP) is an object in the form $\langle a, b\rangle$, where $a, b \in [0, 1]$ and $a + b \leq 1$, that is used as an evaluation of some object or process

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New Modified Level Operator N_γ Over Intuitionistic Fuzzy Sets

Vassia Atanassova(✉)

Bioinformatics and Mathematical Modelling Department,
Institute of Biophysics and Biomedical Engineering,
Bulgarian Academy of Sciences,
105 Acad. Georgi Bonchev Street, 1113 Sofia, Bulgaria
vassia.atanassova@gmail.com

Abstract. The present paper takes the idea of the level operator $N_{\alpha,\beta}$ and proposes a modification called N_γ. The aim of the original level operator is to generate a subset of an intuitionistic fuzzy set A, called (α, β)-set, whose degrees of membership are above a given level (threshold) α and degrees of non-membership are below a given level β, where both α, β are fixed numbers in the [0, 1] interval and $\alpha + \beta \leq 1$. In the modification proposed here, we introduce the operator N_γ that also generates a subset of an intuitionistic fuzzy set A, where the elements of the subset are those elements of A, for which the ratio of their degrees of membership to their degrees of non-membership, respectively, is greater or equal to a given number $\gamma > 0$.

Keywords: Intuitionistic fuzzy sets · Level operator · InterCriteria analysis

1 Introduction

Following the idea of a fuzzy sets of level α, in [5] K. Atanassov introduced the concept of (α, β)-set, generated by an intuitionistic fuzzy sets A in a universe E, where $\alpha, \beta \in [0, 1]$, $\alpha + \beta \leq 1$, are fixed numbers. The formal notation of the operator producing this subset of A is the following:

$$N_{\alpha,\beta}(A) = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in E \,\&\, \mu_A(x) \geq \alpha \,\&\, \mu_A(x) \leq \beta\}.$$

Obviously, this level operator decreases the number of elements, preserving only those elements whose degrees of membership are above a given level (threshold) α and their degrees of non-membership are below a given level β. A series of properties of the operator $N_{\alpha,\beta}$ are checked, involving the set-theoretic operations "negation", "union", "intersection" and the relation "inclusion". Several trivial modifications have also been introduced.

Although $N_{\alpha,\beta}$ as such has not been referred to in the context of the recently proposed method of InterCriteria Analysis (ICA, first defined in [8]), the idea embodied in this level operator has already been heavily used. In ICA, a dataset of evaluations or measurements of m different objects against n different criteria is processed in order to calculate the pairwise correlations between the n criteria in the form of intuitionistic

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Cuckoo Search Algorithm for Model Parameter Identification

Olympia Roeva*, Vassia Atanassova

Institute of Biophysics and Biomedical Engineering
Bulgarian Academy of Sciences
105 Acad. G. Bonchev Str.
Sofia 1113, Bulgaria
E-mails: olympia@biomed.bas.bg,
vassia.atanassova@gmail.com

**Corresponding author*

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Abstract: *In this paper, the metaheuristics algorithm Cuckoo Search (CS), is adapted and applied for a model parameter identification of an E. coli fed-batch cultivation process. The dynamics of bacteria growth and substrate (glucose) utilization is described by a system of ordinary nonlinear differential equations. Using real experimental data set from an E. coli MC4110 fed-batch cultivation process a parameter optimization is performed. The simulation results indicate that the applied algorithm is effective and efficient. As a result, a model with high degree of accuracy is obtained applying the CS. The simulation results and comparison with genetic algorithm and ant colony optimization algorithm confirm the effectiveness of the applied CS algorithm in solving a cultivation model parameter identification problem.*

Keywords: *Metaheuristic algorithm, Cuckoo search, E. coli cultivation, Parameter identification.*

Introduction

More and more metaheuristic algorithms inspired by animal behavior phenomena has received considerable attention among researchers in case of solving complex optimization problems [2, 20, 24]. Algorithms like genetic algorithms (GA) and evolution strategies, ant colony optimization (ACO) [5], artificial bee colony (ABC) optimization [7], bat algorithm (BA) [27], Firefly algorithm (FA) [22], particle swarm optimization (PSO) [9], etc. are among a broad class of meta-heuristics that have been developed. The so-called *nature-inspired* metaheuristic algorithms have been used in a wide range of optimization problems [23].

Parameter identification of a nonlinear dynamic model of a cultivation process is more difficult than that of a linear one, as no general analytic results exist. Some of the difficulties that may arise include: convergence to local solutions if standard local methods are used, over-determined models, badly scaled model function, etc. Due to the nonlinearity and constrained nature of the cultivation process systems, these problems are very often multimodal. Thus, traditional gradient-based methods may fail to identify the global solution. Despite the availability of multiple various global optimization methods, the efficacy of the optimization method is always problem-dependent. In this case, nature-inspired optimization algorithms have received the early attention.

There are already several applications of metaheuristic algorithms to cultivation process modelling and control – GA [4, 13, 19], FA [15], ACO [17] and BA [16]. The published

Blood Plasma Thermograms Dataset Analysis by Means of InterCriteria and Correlation Analyses for the Case of Colorectal Cancer

Svetla Todinova[1], Deyan Mavrov[2], Sashka Krumova[1], Pencho Marinov[3], Vassia Atanassova[1], Krassimir Atanassov[1], Stefka G. Taneva[1,*]

[1]*Institute of Biophysics and Biomedical Engineering*
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 21 & Bl. 105, 1113 Sofia, Bulgaria
E-mails: todinova@abv.bg, sashka@bio21.bas.bg, vassia.atanassova@gmail.com, krat@bas.bg, sgtaneva@gmail.com

[2]*Computer Systems and Technologies Department*
"Prof. Dr. Asen Zlatarov" University
1 Prof. Yakimov Blvd., 8010 Burgas, Bulgaria
E-mail: dg@mavrov.eu

[3]*Institute of Information and Communication Technologies*
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 25A, 1113, Sofia, Bulgaria
E-mail: pencho@parallel.bas.bg

[*]*Corresponding author*

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Abstract: *The approaches of InterCriteria Analysis and Correlation Analysis are applied to a dataset of calorimetric and statistical parameters obtained from blood plasma proteome thermograms of colorectal cancer patients. The analysis was performed for four individual predefined subsets of calorimetric profiles. Specific interrelations between the studied criteria were identified that were found to differ among the different calorimetric subsets. For three of the subsets the enthalpy of the thermal profiles was in strong consonance with the excess heat capacity of the immunoglobulins assigned thermal transition. For the calorimetric subsets that differed most from the control healthy set a strong interrelation between the excess heat capacities of the main plasma proteins (albumin and immunoglobulins) was additionally evident. Our results demonstrate that these mathematical approaches can complement the analysis of calorimetric datasets generated for a variety of diseases.*

Keywords: *InterCriteria analysis, Correlation analysis, Differential scanning calorimetry, Colorectal cancer.*

Introduction

Differential scanning calorimetry (DSC) was recognized as a useful tool for thermodynamic characterization of the blood plasma proteome in a variety of diseases (see [5-10, 12-15]). The DSC scan (thermogram) allows for the determination of transition temperatures (T_m), excess heat capacities (c_P) of the successive thermally induced transitions and the calorimetric enthalpy of denaturation (ΔH_{cal}, i.e. the integrated area under the heat capacity curve) of the plasma proteome. Applied to colorectal cancer (CRC) it revealed strong modification of the CRC calorimetric profiles compared to the typical one of healthy individuals. Since the

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Compass-and-straightedge constructions in the intuitionistic fuzzy interpretational triangle: two new intuitionistic fuzzy modal operators

Vassia Atanassova[1] **and Lyubka Doukovska**[2]

[1] Department of Bioinformatics and Mathematical Modelling
Institute of Biophysics and Biomedical Engineering
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 105, Sofia 1113, Bulgaria,
e-mail: vassia.atanassova@gmail.com

[2] Department of Intelligent Systems
Institute of Information and Communication Technologies
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 2, Sofia 1113, Bulgaria,
e-mail: doukovska@iit.bas.bg

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Abstract: The idea about the two new intuitionistic fuzzy modal operators, proposed here, was inspired by a review of the modal operators defined over intuitionistic fuzzy sets and the observation that graphically all of them are constructed by orthogonal projections. Here for the first time, we propose a new method of constructing two different modal operators, using a compass-and-straightedge construction, producing for each point from the intuitionistic fuzzy interpretational triangle, the two points onto the triangle's hypothenuse that are respectively equidistant from the Truth and the Falsity as the point itself. The properties of these so-constructed new intuitionistic fuzzy operators are studied and formulated in two theorems.
Keywords: Intuitionistic fuzzy modal operator, Intuitionistic fuzzy interpretational triangle, Ruler-and-compass construction, InterCriteria Analysis.
AMS Classification: 03E72.

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Intercriteria analysis: From pairs to triples

Vassia Atanassova[1,*], Lyubka Doukovska[2,*], Alzbeta Michalikova[3] and Irina Radeva[2]

Bioinformatics and Mathematical Modelling Department
Institute of Biophysics and Biomedical Engineering
Bulgarian Academy of Sciences
105 Acad. G. Bonchev Str., Sofia 1113, Bulgaria
e-mail: vassia.atanassova@gmail.com

Intelligent Systems Department
Institute of Information and Communication Technologies
Bulgarian Academy of Sciences
2 Acad. G. Bonchev Str., Sofia 1113, Bulgaria
e-mails: {doukovska; iradeva}@iit.bas.bg

Faculty of Natural Sciences
Matej Bel University
Tajovského 40, 974 01, Banská Bystrica, Slovakia
e-mail: alzbeta.michalikova@umb.sk

* *Corresponding authors*

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Abstract: As a subsequent step in the theoretical research of the decision support method of Intercriteria Analysis (ICA), the authors focus on the idea of having triples of criteria in positive consonance. For this aim, we use as an example to illustrate our research the data from the World Economic Forums' Global Competitiveness Reports for the year 2016-2017. The work hypothesis is that, given a record of intercriteria pairs that have exhibited positive consonance over a longer period of time, triples and *n*-tuples of more criteria can be detected among them featuring high enough pairwise consonance. Here the algorithm is proposed to identify and rank intercriteria triples. The particular interpretation of such triple of intercriteria consonances is a matter of further investigation by problem-specific experts.
Keywords: Intercriteria analysis, Intuitionistic fuzzy sets, Correlation, Consonance.
AMS Classification: 03E72.

Interpretation in the Intuitionistic Fuzzy Triangle of the Results, Obtained by the InterCriteria Analysis

Vassia Atanassova

Department of Bioinformatics and Mathematical Modelling
Institute of Biophysics and Biomedical Engineering
105 "Acad. G. Bonchev" Str., Sofia 1113, Bulgaria
e-mail: vassia.atanassova@gmail.com

Abstract

The present research is a consequent step in an ongoing research of a novel approach for decision support, called *InterCriteria Analysis*, which aims at identification of specific correlations between criteria in a decision making processes, using the concepts of intuitionistic fuzziness and index matrices. The step made here is not a gradual improvement of previous results, but a new way of reading them. It is shown how the results produced by the InterCriteria Analysis approach can be interpreted within the specific triangular geometrical interpretation of IFSs, thus allowing us to order these results according simultaneously to the membership and the non-membership component of the intuitionistic fuzzy pairs.

Keywords: InterCriteria Analysis, Intuitionistic fuzziness, Index matrix, Decision support.

1. Introduction

The results in this work are continuation of a recently started research in the field of intuitionistic fuzzy sets (IFSs) based decision support approach, titled *InterCriteria Analysis* (ICA). The approach is specifically applicable to situations where some of the criteria in the decision making process come at a higher cost than others, for instance are harder, more expensive, more human resource or time consuming to measure or evaluate. Such criteria have been considered unfavourable in ICA, hence if the method identifies certain, high enough, level of correlation between such unfavourable criteria and others that are easier, cheaper or quicker to measure or evaluate, these might be disregarded in the further decision making process.

The approach employs two fundamental concepts: intuitionistic fuzzy sets [1, 2, 5, 6] and index matrices (IMs) [4, 7].

Here we will briefly repeat the theoretical framework of the proposed approach, firstly proposed in [8], by slightly improving the notation from [9]. The approach employs an index matrix M of m rows $\{O_1, \ldots, O_m\}$ and n columns $\{C_1, \ldots, C_n\}$, where for every p, q ($1 \leq p \leq m$, $1 \leq q \leq n$), O_p in an evaluated object, C_q is a evaluation criterion, and $e_{O_pC_q}$ is the evaluation of the p-th object against the q-th criterion, defined as a real number or another object that is comparable according to relation R with all the rest elements of the index matrix M.

$$M = \begin{array}{c|ccccccc} & C_1 & \ldots & C_k & \ldots & C_l & \ldots & C_n \\ O_1 & e_{O_1,C_1} & \ldots & e_{O_1,C_k} & \ldots & e_{O_1,C_l} & \ldots & e_{O_1,C_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ O_i & e_{O_i,C_1} & \ldots & e_{O_i,C_k} & \ldots & e_{O_i,C_l} & \ldots & e_{O_i,C_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ O_j & e_{O_j,C_1} & \ldots & e_{O_j,C_k} & \ldots & e_{O_j,C_l} & \ldots & e_{O_j,C_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ O_m & e_{O_m,C_1} & \ldots & e_{O_m,C_j} & \ldots & e_{O_m,C_l} & \ldots & e_{O_m,C_n} \end{array},$$

From the requirement for comparability above, it follows that for each i, j, k it holds the relation $R(e_{O_iC_k}, e_{O_jC_k})$. The relation R has dual relation $\overline{R}$, which is true in the cases when relation R is false, and vice versa.

For the needs of our decision making method, pairwise comparisons between every two different criteria are made along all evaluated objects. During the comparison, it is maintained one counter of the number of times when the relation R holds, and another counter for the dual relation.

Let $S^{\mu}_{k,l}$ be the number of cases in which the relations $R(e_{O_iC_k}, e_{O_jC_k})$ and $R(e_{O_iC_l}, e_{O_jC_l})$ are simultaneously satisfied. Let also $S^{\nu}_{k,l}$ be the number of cases in which the relations $R(e_{O_iC_k}, e_{O_jC_k})$ and its dual $\overline{R}$ $(e_{O_iC_l}, e_{O_jC_l})$ are simultaneously satisfied. As the total number of pairwise comparisons between the object is $m(m-1)/2$, it is seen that there hold the inequalities:

$$0 \leq S^{\mu}_{k,l} + S^{\nu}_{k,l} \leq \frac{m(m-1)}{2}.$$

For every k, l, such that $1 \leq k \leq l \leq m$, and for $m \geq 2$ two numbers are defined:

$$\mu_{C_k,C_l} = 2\frac{S^{\mu}_{k,l}}{m(m-1)}, \ \nu_{C_k,C_l} = 2\frac{S^{\nu}_{k,l}}{m(m-1)}.$$

The pair, constructed from these two numbers, plays the role of the intuitionistic fuzzy evaluation of the relations that can be established between any two criteria C_k and C_l. In this way the index matrix M that relates evaluated objects with evaluating criteria can be transformed to another index matrix M^* that gives the relations among the criteria:

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InterCriteria analysis of genetic algorithm parameters in parameter identification

Tania Pencheva, Maria Angelova, Vassia Atanassova and Olympia Roeva

Institute of Biophysics and Biomedical Engineering
Bulgarian Academy of Sciences
105 Acad. G. Bonchev Str., Sofia 1113, Bulgaria
e-mails: tania.pencheva@biomed.bas.bg, maria.angelova@biomed.bas.bg,
vassia.atanassova@gmail.com, olympia@biomed.bas.bg

Abstract: An application of InterCriteria Analysis (ICA) – recently proposed approach for multicriteria decision support – is here presented. The apparata of Index Matrices and Intuitionistic Fuzzy Sets are in the grounds of ICA. In this investigation, ICA is applied to examine the influences of genetic algorithms parameters during the model parameter identification of *E. coli* MC4110 and *S. cerevisiae* fermentation processes. The impact of two of the main genetic algorithms parameters, namely number of individuals and number of generations, is here studied. The obtained results after ICA application are discussed towards convergence time and model accuracy. Some conclusions about existing relations and dependencies between genetic algorithms parameters, from one side, and fermentation process model parameters from the other side, are derived.
Keywords: InterCriteria analysis, Intuitionistic fuzzy sets, Genetic algorithms, Fermentation process, *E. coli*, *S. cerevisiae*.
AMS Classification: 03E72.

1 Introduction

InterCriteria Analysis (ICA) is a recently developed approach [3] aiming to go beyond the nature of the criteria involved in a process of evaluation of multiple objects against multiple criteria, and, on this basis, to discover any existing correlations between the criteria themselves. Given in details in [3], ICA has been further applied for the purposes of temporal, threshold and trends analyses of an economic case-study of European Union member states' competitiveness [8, 9, 10].

InterCriteria Decision Making Approach to EU Member States Competitiveness Analysis: Temporal and Threshold Analysis

Vassia Atanassova[1,3], Lyubka Doukovska[1],
Deyan Mavrov[2], and Krassimir T. Atanassov[2,3]

[1] Intelligent Systems Department,
IICT – Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., bl. 2, 1113 Sofia, Bulgaria
vassia.atanassova@gmail.com,
doukovska@iit.bas.bg
[2] Computer Systems and Technologies Department,
"Prof. Dr. Asen Zlatarov" University,
1 "Prof. Yakimov" Blvd., 8010 Burgas, Bulgaria
dg@mavrov.eu
[3] Bioinformatics and Mathematical Modelling Department,
IBPhBME – Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., bl. 105, 1113 Sofia, Bulgaria
krat@bas.bg

Abstract. In this paper, we present some interesting findings from the application of our recently developed InterCriteria Decision Making (ICDM) approach to data extracted from the World Economic Forum's Global Competitiveness Reports for the years 2008–2009 to 2013–2014 for the current 28 Member States of the European Union. The developed approach which employs the apparatuses of index matrices and intuitionistic fuzzy sets is designed to produce from an existing index matrix with multiobject multicriteria evaluations a new index matrix that contains intuitionistic fuzzy pairs with the correlations revealed to exist in between the set of evaluation criteria, which are not obligatory there 'by design' of the WEF's methodology but exist due to the integral, organic nature of economic data. Here, we analyse the data from the six-year period within a reasonably chosen intervals for the thresholds of the intuitionistic fuzzy functions of membership and non-membership, and make a series of observations about the current trends in the factors of competitiveness of the European Union. The whole research and the conclusions derived are in line with WEF's address to state policy makers to identify and strengthen the transformative forces that will drive future economic growth.

Keywords: Global Competitiveness Index, Index matrix, InterCriteria decision making, Intuitionistic fuzzy sets, Multicriteria decision making.

1 Introduction

The present work contains a continuation of our recent research, started in [7], which aims at analyzing data about the performance of the 28 European Union Member

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InterCriteria Decision Making Approach to EU Member States Competitiveness Analysis: Trend Analysis

Vassia Atanassova[1], Lyubka Doukovska[2],
Dimitar Karastoyanov[3], and František Čapkovič[4]

[1] Intelligent Systems Department, IICT – Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., bl. 2, 1113 Sofia, Bulgaria
and Bioinformatics and Mathematical Modelling Dept.,
IBPhBME – Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., bl. 105, 1113 Sofia, Bulgaria
vassia.atanassova@gmail.com
[2] Intelligent Systems Department, IICT – Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., bl. 2, 1113 Sofia, Bulgaria
doukovska@iit.bas.bg
[3] Intelligent Systems Department, IICT – Bulgarian Academy of Sciences
Acad. G. Bonchev Str., bl. 2, 1113 Sofia, Bulgaria
dkarast@iinf.bas.bg
[4] Institute of Informatics, Slovak Academy of Sciences,
Dubravska cesta 9, 845 07 Bratislava, Slovak Republic
Frantisek.Capkovic@savba.sk

Abstract. In this paper, we continue our investigations of the newly developed InterCriteria Decision Making (ICDM) approach with considerations about the more appropriate choice of the employed intuitionistic fuzzy threshold values. In theoretical aspect, our aim is to identify the relations between the thresholds of inclusion of new elements to the set of strictly correlating criteria and the numbers of correlating pairs of criteria thus formed. We illustrate the findings with data extracted from the World Economic Forum's Global Competitiveness Reports for the years 2008–2009 to 2013–2014 for the current 28 Member States of the European Union. The study of the findings from the considered six-year period involves trend analysis and computation of two approximating functions: a linear function and a polynomial function of 6^{th} order. The per-year trend analysis of each of the 12 criteria, called 'pillars of competitiveness' in the WEF's GCR methodology, gives an opportunity to prognosticate their values for the forthcoming year 2014–2015.

Keywords: Global Competitiveness Index, InterCriteria decision making, Intuitionistic fuzzy sets, Multicriteria decision making, Trend analysis.

1 Introduction

In a series of papers, we have started investigating the application of the newly proposed InterCriteria Decision Making (ICDM) approach, based on the concepts of

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Intercriteria Decision Making: A New Approach for Multicriteria Decision Making, Based on Index Matrices and Intuitionistic Fuzzy Sets

Krassimir Atanassov[1,2], Deyan Mavrov[2], Vassia Atanassova[1]

[1] Dept. of Bioinformatics and Mathematical Modelling
IBPhBME, Bulgarian Academy of Sciences
105 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria
e-mails: krat@bas.bg, vassia.atanassova@gmail.com

[2] Prof. Asen Zlatarov University
1 "Prof. Yakimov" Blvd., Burgas8000, Bulgaria
e-mail: dg@mavrov.eu

Abstract: A new approach for multicriteria decision making is introduced in the paper. It is called "Intercriteria decision making". It is based on the apparatusa of the index matrices and the intuitionistic fuzzy sets and can be applied for decision making in different areas of science and practice.
Keywords and phrases: Index matrix, InterCriteria decision making, Intuitionistic fuzzy set.
2000 Mathematics Subject Classification: 03E72.

1 Introduction

A novel method for decision making, based on Index Matrices (IMs; see [1, 2, 3]) and Intuitionistic Fuzzy Sets (IFSs, see [4]) is introduced.

The IMs are esentially new and not widely known mathematical objects, that are extensions of the ordinary matrices. They are discussed in Section 3. In the paper we use also the concept of an Intuitionistic Fuzzy Pair (IFP, see [5]), that will be described in Section 2.