АВТОРСКА СПРАВКА

**За научните приноси от трудовете
на главен асистент доктор Деян Георгиев Мавров,
катедра „Компютърни и информационни технологии", Факултет по природни науки,
Университет „Проф. д-р Асен Златаров" – Бургас**

1. Обобщение на научните и научноприложните приноси

За целите на конкурса представям две публикации като хабилитационен труд и десет публикации за изпълнение на останалите изисквания. Всички публикации описват резултатите от проучвания свързани с областта на компютърните науки

Като обща тема на публикациите и проучванията може да се разглежда търсенето на начини теоретичните апарати на интуиционистки размитата логика и индексираните матрици да бъдат приложени практически за анализ на различни видове данни и като помощно средство при обработка на данни.

В периода 2016–2018 г. повечето от публикациите са свързани с различни приложения на Интеркритериалния анализ (разработен заедно с К. Атанасов и В. Атанасова и част от дисертационния ми труд), който генерира интуиционистки размити оценки за взаимната зависимост между даден брой критерии, по които се оценяват едни и същи обекти, като оценките са разположени в индексирана матрица. Ако оценките по два критерия нарастват и намалят паралелно се счита, че критериите са в положителен консонанс, ако при нарастване на оценките на единия тези на другия намалят – в отрицателен консонанс, а ако не е открита зависимост – в дисонанс. ИКА е приложен върху числови данни от медицината (2.2.1, 2.2.5) и транспорта (2.2.2), а вариант на ИКА за търсене на тройки критерии е използван като помощно средство за намаляване на броя променливи на входа на невронните мрежи (2.2.4). В друга статия (2.2.6) е използван оператора N_γ, за да се определят по нов начин праговете, при които критериите се считат в консонанс и е предложен начин за изчисляване на параметъра γ чрез топологичните оператори „отваряне" и „затваряне".

В няколко публикации след 2020 г. се използват програмни библиотеки за работа с индексирани матрици (ИМ), написани първоначално като част от дисертационния ми труд, за да бъдат приложени и анализирани статистически и други алгоритми, които използват ИМ и операциите с тях за получаване на крайния си резултат. Работата с тези програми улеснява изпълнението и коригирането на тези алгоритми, особено при работа с ИМ от интуицинистки размити двойки. Библиотеките позволяват работа с ИМ от различни типове стойности, а покрай работата по прилагане на гореспоменатите алгоритми в тях бяха добавени някои нови операции и беше разработен нов тип данни за съхранение на интуиционистки размити двойки, интервални двойки и ИРД с интервални

стойности. В две публикации са реализирани еднофакторна(2.2.10) и двуфакторна (2.2.7) интуиционистки размита ANOVA с индексирани матрици и разработените програми са приложени за анализ съответно на влиянието на фактора „географското положение" (2.2.10) и на комбинацията от факторите „гъстота на населението" и „климатична зона" (2.2.7) на страните в Европа върху разпространението на COVID-19 в тях. В трета публикация е реализиран интуиционистки размит подход за избиране на изпълнител за аутсорсинг, използващ ИМ и интуиционистки размити двойки с интервални стойности (2.2.8).

В две от публикациите се създават модели с обобщени мрежи - обобщение на мрежите на Петри, които се използват за моделиране на паралелни процеси – един на процес на клъстерен анализ (2.2.3) и един на система за противопожарно наблюдение на горски терен с безпилотни летателни апарати (2.2.9).

През 2021–2022 г. като част от работата по проект за изследване на горски пожари беше разработено приложение за двумерен анализ на разрастването на пожари, използвайки Игровия метод за моделиране върху квадратна мрежа, описваща терена и гъстотата на растителността върху него (2.1.1). То беше приложено върху модел на местност, където е горял реален пожар и резултатите бяха сравнени с реалните последствия на пожара и резултатите от друга програма (2.1.2). Резултатите от тази работа са описани в две публикации.

2. Резюмета на използваните публикации

Резюметата на публикациите в двете подсекции са подредени в хронологичен възходящ ред.

2.1. Хабилитационен труд

2.1.1. Mavrov, D.G., Bureva, V. FireGrid - Software for 2D Fire Spread Simulation Using the Game Method for Modelling. International Journal Bioautomation, 26 (1), 2021, pp. 5-18. DOI: 10.7546/ijba.2022.26.1.000880

The paper presents FireGrid, an application software program for performing two-dimensional fire spread simulation using Atanassov's Game Method for Modelling (GMM). The software implements a model of fire spread with one or more starting points of ignition onto a planar grid of square cells that represent an idealized terrain of flammable areas of vegetation, and inflammable areas of rocks and water basins. The applications allows also locating a fire's starting point(s) by subtracting the initial configuration from the final one and decrementing all affected and adjacent cells by one. In addition to the preliminary defining the pattern of fire spread, manual control of the spread is allowed during simulation by selecting the cells that are to burn on the next iteration.

2.1.2. Mavrov, D., Atanassova, V., Bureva, V., Roeva, O., Vassilev, P., Tsvetkov, R., Zoteva, D., Sotirova, E., Atanassov, K., Alexandrov, A., Tsakov, H. Application of Game Method for Modelling and Temporal Intuitionistic Fuzzy Pairs to the Forest Fire Spread in the Presence of Strong Wind. Mathematics, 10 (8), 2022, art. no. 1280. DOI: 10.3390/math10081280

In a series of papers, the initiation and development of forest fires are described in terms of the cellular automata-based Game Method for Modelling (GMM), modelling a particular area as an orthogonal grid of square cells whose values are changing with respect to predefined rules. In the present leg of this research, the simulation of the wildfire that occurred in the Kresna Gorge in Bulgaria in August 2017 is presented, rendering an account of the wind, characterized by its direction and intensity, and evaluating the impact of the fire iteratively in terms of temporal intuitionistic fuzzy sets that maintain the information about the degrees of burnt and unaffected areas. The results from the software product FireGrid, implementing the GMM-model developed by the authors, are also compared to the results from the software application FlamMap. Additionally, the paper presents for the first time the basic properties of the defined operations and operators over temporal intuitionistic fuzzy pairs.

2.2. Други публикации

2.2.1. Todinova, S., Mavrov, D., Krumova, S., Marinov, P., Atanassova, V., Atanassov, K., Taneva, S.G. Blood plasma thermograms dataset analysis by means of intercriteria and correlation analyses for the case of colorectal cancer. International Journal Bioautomation, 20 (1), 2016, pp. 115-124.

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.

2.2.2. Valkov, I., Mavrov, D., Sotirova, E. Intercriteria analysis over public transport system data. 2016 IEEE 8th International Conference on Intelligent Systems, IS 2016 - Proceedings, art. no. 7737479, pp. 560-563. DOI: 10.1109/IS.2016.7737479

In the current paper is presented an application of the InterCriteria Decision Making (ICDM) approach to data connected with integrated public transport system of the city of Burgas. The aim is to analyze the data on passenger flow for each month and then to analyze the correlations between pairs of bus lines with the InterCriteria Analysis Method. As a result we can optimize the public transport system by reducing the redundant lines.

2.2.3. Bureva, V., Sotirova, E., Popov, S., Mavrov, D., Traneva, V. Generalized net of cluster analysis process using STING: A statistical information grid approach to spatial data mining. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 10333 LNAI, 2017, pp. 239-248. DOI: 10.1007/978-3-319-59692-1_21

Cluster analysis is one of the main topics in data mining. It helps to group elements with similar behavior in one group. Therefore, a good clustering method will produce high quality clusters containing objects similar to one another within the same group and dissimilar to the objects in other clusters. In the current research work one of the basic grid-based methods for clustering is modelled using Generalized nets.

2.2.4. Sotirov, S., Atanassova, V., Sotirova, E., Doukovska, L., Bureva, V., Mavrov, D., Tomov, J. Application of the Intuitionistic Fuzzy InterCriteria Analysis Method with Triples to a Neural Network Preprocessing Procedure. Computational Intelligence and Neuroscience, 2017, art. no. 2157852. DOI: 10.1155/2017/2157852

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.

2.2.5. Krumova, S., Todinova, S., Mavrov, D., Marinov, P., Atanassova, V., Atanassov, K., Taneva, S.G. Intercriteria analysis of calorimetric data of blood serum proteome. Biochimica et Biophysica Acta - General Subjects, 1861 (2), 2017, pp. 409-417. DOI: 10.1016/j.bbagen.2016.10.012

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.

2.2.6. Doukovska, L., Atanassova, V., Mavrov, D., Radeva, I. Intercriteria analysis of EU competitiveness using the level operator N_γ. Advances in Intelligent Systems and Computing, 641, 2018, pp. 631-647. DOI: 10.1007/978-3-319-66830-7_56

A recent leg of research on a new level operator over intuitionistic fuzzy sets, N_γ, inspired the development of a new approach to establishing the thresholds for evaluation of the results of application of the InterCriteria Analysis (ICA) over multiobject multicriteria problems. ICA is a novel method of detecting the levels of pairwise correlations within the set of criteria (termed here positive consonance, negative consonance and dissonance), which uses as input the dataset of measurements or evaluations of a set of objects against these criteria. The output of ICA, being a matrix of intuitionistic fuzzy pairs, gives all possible consonances and dissonances between the pairs of criteria, and it is a matter of either expert decision or algorithmic solution what thresholds of precision will be implemented to outline the top correlating pairs of criteria and yield certain domain-specific conclusions from the data. The present paper discusses practical aspects of selecting these top performing pairs of criteria with the use of the newly proposed intuitionistic fuzzy level operator N_γ. For illustrative purposes, we analyze the dataset of 28 EU member states' performance from the Global Competitiveness Report of the World Economic Forum for the year 2016–2017. Further, we comment on the interval in which parameter γ reasonably varies, making use of the intuitionistic fuzzy interpretational triangle and the topological operators Interior and Closure.

2.2.7. Traneva, V., Mavrov, D., Tranev, S. Fuzzy Two-Factor Analysis of COVID-19 Cases in Europe. 2020 IEEE 10th International Conference on Intelligent Systems, IS 2020 - Proceedings, art. no. 9199947, pp. 533-538. DOI: 10.1109/IS48319.2020.9199947

In this paper we apply an intuitionistic fuzzy two-factor ANOVA (2-D IFANOVA), based on the concepts of intuitionistic fuzzy sets (IFSs) and index matrices (IMs), over a unique dataset of daily COVID-19 cases up to 24 June 2020 to explore how the number of COVID-19 cases depends on the "density" and "climate zone" factors for the continent of Europe. In the source data, some information may be missing, unclear or imprecise. To deal with the uncertainty in the data, we apply Intuitionistic fuzzy logic. We also present a new software utility, which performs 2-D IFANOVA by using an implementation of Index matrices. Finally, a comparative analysis of the results obtained by the classical ANOVA and IFANOVA is performed.

2.2.8. Traneva, V., Tranev, S., Mavrov, D. Interval-Valued Intuitionistic Fuzzy Decision-Making Method using Index Matrices and Application in Outsourcing. Proceedings of the 16th Conference on Computer Science and Intelligence Systems, FedCSIS 2021, pp. 251-254. DOI: 10.15439/2021F77

Selecting a suitable outsourcing service provider is a challenging problem that requires discussion among a group of experts. The problems of this type belongs to the area of multicriteria decision-making. Interval-valued intuitionistic fuzzy sets, which are an extension of intuitionistic fuzzy sets, are a capable tool in modeling uncertain problems. In this paper we will formulate an optimal interval-valued intuitionistic fuzzy multicriteria decision-making problem in outsourcing and propose a new approach for the selection of the most appropriate candidates;

as well as a software program for its automated solution, based on our previous libraries. As an example of a case study, an application of the algorithm on real data from a refinery is demonstrated.

2.2.9. Atanassov, K.T., Vassilev, P., Atanassova, V., Roeva, O., Iliev, R., Zoteva, D., Bureva, V., Mavrov, D., Alexandrov, A. Generalized net model of forest zone monitoring by UAVs. Mathematics, 9 (22), 2021, art. no. 2874, DOI: 10.3390/math9222874

The paper presents a generalized net (GN) model of the process of terrain observation with the help of unmanned aerial vehicles (UAVs) for the prevention and rapid detection of wildfires. Using a GN, the process of monitoring a zone (through a UAV, which is further called a reconnaissance drone) and the localization of forest fires is described. For a more indepth study of the terrain, the reconnaissance drone needs to coordinate with a second UAV, called a specialized drone, so that video and sensory information is provided to the supervising fire command operational center. The proposed GN model was developed to assist in the decision-making process related to the coordination of the operation of both UAVs under dynamically changing terrain circumstances, such as those related to preventing or quickly containing wildfires. It describes the stages (transitions), logical determinants (transition predicate matrices), and directions of information flow (token characteristics) within the process of localization of fires using the pair of reconnaissance and specialized drones.

2.2.10. Traneva, V., Mavrov, D., Tranev, S. Software Utility of One-Way Intuitionistic Fuzzy ANOVA. Lecture Notes in Networks and Systems, 504 LNNS, 2022, pp. 681-689. DOI: 10.1007/978-3-031-09173-5_79

The post-COVID-19 era will bring forward a new normal - one that will accelerate digital transformation in many areas as one solution to avoid severe economic consequences. Many factors have been considered as a possible influence on the diffusion of COVID-19 around the world - one such factor being the geographic location of each country. One-way Analysis of Variance (ANOVA) studies the influence of a single factor on a variable. In a previous publication, we proposed one-way intuitionistic fuzzy ANOVA (1-D IFANOVA), based on the formalisms of Index Matrices (IMs) and Intuitionistic Fuzzy Sets (IFSs), which is a modification of classical ANOVA. In this paper, we will introduce a command-line utility for the calculation of IFANOVA results which performs the algorithm using Intuitionistic Fuzzy Pairs (IFPs). Then we will apply IFANOVA to clarify how the number of daily reported cases in European countries depends on their geographic location, using the dataset of ECDPC daily cases from January 1 to December 31, 2021. We will also analyze the data with classical ANOVA and will perform a comparative analysis of the results obtained from that and from IFANOVA.

15.09.2022 г.   Подпис:
Бургас
                                                            (Д. Г. Мавров)