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1st INTERNATIONAL LOTFI A.ZADEH CONFERENCE

FUZZY LOGIC AND APPLICATIONS

DECEMBER 20 - 21, 2021

BAKU STATE UNIVERSITY
BAKU, AZERBAIJAN

BOOK OF ABSTRACTS

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SELECTIVE PROPERTIES IN FUZZY AND SOFT TOPOLOGICAL SPACES

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Selection principles theory is one of most studied topics in Topology in recent years. Howeve, there are very few papers about selection principles in the context of fuzzy and soft topological spaces. We present some known and some new results on the classical selection principles of Menger, Hurewicz and Rothberger and their variations in fuzzy and soft topological structures. Also, we suggest the study of star selection principles in these structures. Some open questions and lines of further investigation will be discussed.

A MODERN APPROACH TO FUZZY SYSTEMS AS A BRIDGE BETWEEN CONNECTIONIST AND SYMBOLIC SYSTEMS

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This year marks the 100th anniversary of the birth of the great scientist of our time, the founder of several major scientific trends in applied mathematics, automatic control theory, computer science and artificial intelligence, Professor Lotfi Zadeh. He belonged to the cohort of very few pioneering scientists who generate new, original scientific ideas and form the basic scientific paradigms that change our world. Professor L. Zadeh was the founder of the theory of fuzzy sets and linguistic variables, the "father" of fuzzy logic and approximate reasoning, the author of the theory of possibility and general theory of uncertainty, the creator of Z-numbers theory and generalized restrictions, the ancestor of granular and soft computing. His ideas and theories not only opened a new epoch in the development of scientific

thought, free from the limitations of narrow scientific directions and contributing to their synergy. They made a significant contribution to the development of new information and cognitive technologies, led to the creation of effective industrial technologies, such as fuzzy computers and processors, fuzzy regulators, fuzzy clustering and recognition systems, and many others. Professor L. Zadeh has been deservedly included in the IEEE Computer Society's gallery of fame scientists who have made pioneering contributions to the field of artificial intelligence and intelligent systems.

Soviet scientists were among the first to support the new direction. Speaking at the ICSCCW-2001 conference in June 2001, L. Zadeh stressed that his first paper on fuzzy sets took place in 1965 at a conference on cybernetics held in the USSR aboard the liner «Admiral Nakhimov».

The role of L. Zadeh in AI is also hard to overestimate, and I would especially like to focus on the concept of soft computing, originally combining hybrid models based on fuzzy sets, neural networks, and soft computing. The emergent properties of these models were one of the foundations of the current hype in artificial intelligence and machine learning.

The study of fuzzy logic culminated in the late 20th century and has since begun to slow down a bit. This slowdown may be due in part to the temporary absence of fuzzy math results in machine learning. Current research will pave the way for fuzzy logic researchers to develop AI applications and solve complex problems that are also of interest to the machine learning community. Experience and expertise in fuzzy logic is well suited to model ambiguities in big data, model uncertainty in knowledge representation, and provide transfer learning with noninductive inference.

This talk will examine fuzzy models to improve the effectiveness of XAI systems in explaining their decisions and actions to the user, through fuzzy models. and to establish a concrete and fundamental connection between two important fields in artificial intelligence i.e., symbolic systems and connectionist systems, more specifically, between deep learning and fuzzy logic. Several authors show how deep learning could benefit from the comparative research by re-examining many heuristics in the lens of fuzzy logic.

Very effective is also, the use of fuzzy layers in deep learning networks. The most interesting from the point of view of this research is the extraction of rules using neuro-fuzzy models. Systems based on fuzzy rules, developed using fuzzy logic, have become a field of active research in the last few years. These algorithms have proven their strengths in tasks such as managing complex systems, creating fuzzy controls. The relationship between production rules and neural networks of both worlds has been thoroughly studied and shown to be equivalent. This means that we can translate the knowledge embedded in the neural network into a more cognitively acceptable language - fuzzy rules. In other words, we get a semantic interpretation of neural networks.

As part of this ideology, the Russian Association of Artificial Intelligence is currently actively developing fuzzy situational management of complex systems based on their composite hybrid modelling, which uses the capabilities of analytical, neural network and fuzzy approaches to construct composite hybrid models.

FUZZY RELATIONS AS THE BASE FOR FUZZIFICATION OF DIFFERENT MATHEMATICAL STRUCTURES

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One of the first concepts that appeared in the so called “Fuzzy Mathematics” is the notion of a fuzzy relation introduced in the pioneering paper by Zadeh. A fuzzy function between the elements of sets X and Y is a fuzzy subset of the product $X \times Y$, that is a fuzzy set $R : X \times Y \to [0,1]$. In case R has only two values 0 and 1, that is when $R : X \times Y \to \{0,1\}$, it becomes an ordinary relation between elements of sets X and Y. As simple examples of fuzzy relation on the set R of real numbers are the relation $R_{\approx}$ (approximately equal) and $R_{\leq}$ much less. These relations, fuzzifying the equality relation $R_{=}$ and the relation “less than” $R_{\prec}$ can be defined, for example, respectively by formulas:

$R_{\approx}(x, y) = 2^{-k(x-y)^2}$ where $k \geq 1$, and $x, y \in R$;

$R_{\prec}(x, y) = \left(1 + \frac{1}{(x-y)^2}\right)^{-1}$ if $x \prec y$ and $R_{\prec}(x, y) = 0$ otherwise.

In the first part of our talk we shall discuss some general properties of fuzzy relations, that can be considered as fuzzy counterparts of such well known properties of ordinary relations, as reflexivity, transitivity and symmetry. We shall illustrate these properties and their behavior under different operations by some examples, in particular, by the fuzzy relations $R_{\approx}$ and $R_{\leq}$. In the second part of our talk, we plan to discuss fuzzy counterparts of classic mathematical theories of rough sets, mathematical morphology and concept lattices. The fuzzy counterparts of all these theories base on fuzzy relations. After a brief introduction into these theories, we plan, if the time schedule allows, to touch briefly some of their important applications in the research of different problems related to medicine, geology, biology, social sciences et. al.

MODEL EVALUATION CRITERION BASED ON MEMBERSHIP VALUES

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Various models based on fuzzy systems are used successfully in many application areas such as prediction, optimization, clustering, forecasting and modelling. Evaluation of the performance of models based on fuzzy systems is a very important issue. When evaluating specified models, a performance measure is generally calculated based on the difference between the defuzzified output values and the corresponding observation values. Although fuzzy inference is made over fuzzy sets or numbers, performance measurement is calculated over numerical values in the literature. Therefore, membership values are not considered. In other words, the basic philosophy of fuzzy logic does not participate in the evaluation process. It is clear that a performance measure that considers membership values would be a better criterion for evaluating models based on fuzzy systems. In the evaluation of these models, a performance criterion based on membership values will be introduced, which takes into consideration the membership values and therefore contains the philosophy of fuzzy logic more.

COMPLEX FUZZY EVALUATION OF SOCIAL CAPITAL

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In this paper with the purpose to establish the level of social capital (SC) in the country, two controversial methodologies of preference of expert opinions (PEO) and intuitionistic linguistic assessment of SC are proposed. The Z-number theory facilitated new possibilities to research more kinds of uncertainty problems, especially in the areas of multiple criteria decision making and events stated in natural language. In the first methodology expert opinions given in Z-numbers are fuzzified, then employing average graded general representation technique, fuzzified values are converted into crisp values, finally their priorities are established.

In comparison to the first methodology, in which the core approach is the conversion of crisp data into Z-numbers, in the second methodology expert opinions given in crisp values are converted into Z-numbers. The generation of z-numbers is a practical instrument to make choices among expert evaluations. In the second methodology with the intention to make PEO, the experimental researches on modified generation of Z-numbers based on ordered weighted average and maximum entropy is used.

As a result, with the PEO methodology in two controvertible ways where preferred expert opinions were obtained and inferred results from intuitionistic linguistic aggregation of SC illustrate the level of SC in Azerbaijan.

FUZZY DIFFERENTIAL EQUATIONS IN DIFFERENT METRIC SPACES

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Uncertainties in the real-world problem can be modeled easily with the help of fuzzy set theory when one lacks complete information about the variables and parameters. This concept of fuzzy set theory was first introduced by L.Zadeh [1] in 1965. O.Kaleva [2] have extensively studied the existence and uniqueness of solution of fuzzy differential equations. A general formulation of the first-order fuzzy initial value problem was given by Buckley and Feuring [3].

The main objective of this work is to investigate the Cauchy problem for following fuzzy differential equation in metric spaces with parameters [4]:

$$x'(t) = f(t,x(t)),\ x(t_0) = x_0,$$

Let U be a subspace of normal, convex, upper semi continuous, compactly supported fuzzy sets defined in R^n and assume that $f:[t_0,t_0+a]\times U \to U$ is continuous function. We show that the Cauchy problem has a solution in metric spaces with parameters if and only if U is locally compact.

Parameters of the metric spaces allow, firstly, to study the property of the solution in various metric spaces, moreover, to control the solution in the constructed mathematical models and make them more adequate.

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COMPARISON OF VARIOUS MACHINE LEARNING METHODS FOR DETECTING CYBERBULLYING IN TWITTER MESSAGES

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With the development of the social network, the number of cyberbullying started to increase in the world. Cyberbullying detection is receiving increasing attention, especially in Machine Learning communities. The reason for the increase in cyberbullying is that the bullying on the Internet cannot be detected or even if they are detected, they think that legal sanctions will not be applied. These types of cyberbullying crimes leave mental scars in their lives in the future by putting psychological pressure on people. It is very difficult to identify and counter cyberbullying in a timely manner.

Cyberbullying will be a growing problem in Turkey as in the rest of the world. By the findings so far, 20% are already becoming cyberbullies in Turkey. In this regard, there are few studies in the literature on the detection of cyberbullying in Turkish texts. Machine learning is also being used in ongoing research to detect and eliminate cyberbullying. Although there is a lot of cyberbullying detection in English, there is little research in Turkish.

Moreover, only a limited number of algorithms and methods have been used in Turkish studies. Moreover, the aim of this study is to use different machine learning algorithms to detect Turkish cyberbullying messages. In this study, those who made their quartet drawings on a dataset consisting of 3000 Turkish social networks using cyber techniques. Precision, accuracy, cross-validation, recall and F1 scores were used to appraise the performance of the classifiers. In the study, Linear SVC performed best Train Models for CountVectorizer, with cross-validation score of 89.92% and F1 score of 99.96%, and Linear SVC performed best Train Models for TfidfVectorizer, with cross-validation score of 89.79% and F1 score of 99.96%.

REGULARITY PROPERTIES OF BOUNDARY FUNCTIONS FOR BIORTHOGONAL WAVELETS

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Standard wavelet theory only considers functions on the entire real line. In most practical cases, however, we work with functions defined on closed intervals. There are several different approaches to overcome this problem in the literature. Boundary function approach is one of them. In this study, we start with boundary functions that are defined by recursion relations and obtain approximation order and continuity properties (or regularity properties) directly from the recursion relation for biorthogonal wavelets.

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EVALUATION OF MICROCREDIT BORROWERS USING SOME SCORING AND FUZZY METHODS OF THE RELEVANT DATA ANALYSIS

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The scoring systems used by commercial banks and microcredit organizations use statistical methods of analysis that do not reflect the cause-effect relations between the objective and subjective characteristics of a potential borrower and his level of solvency at a certain date. To assessing the creditworthiness of individuals, in works [1, 2] there are proposed various fuzzy approaches based on the use of a fuzzy inference system (FIS) relative to the level of borrower's solvency. The approach to the assessing of the microcredit potential borrowers is proposed using the fuzzy method of weighted maxmin convolution of qualitative criteria for assessing creditworthiness, which provides for the fuzzification of applicants' personal data, i.e., their representation by appropriate fuzzy sets [3, 4]. Starting from fuzzy formalisms, a multi-criteria assessment of microcredit potential borrowers is considered by using of the FIS. One of the modern tools for analyzing the borrower's solvency for a specific date is the so-called "scoring system", which, based on the applicant's data, promptly analyzes his/her credit history: financial transactions, delays, etc. In the case of microcredit, data about clients is taken as a basis directly from their applications, as well as, if necessary, from other available sources (for example, from social networks). One of the methods of scoring analysis is the scheme proposed in [5]: each potential microcredit borrower is assessed according to the following factors: age (x_1), sex (x_2), settledness (x_3), work risks (x_4), work in large companies (x_5), seniority (x_6), assets (x_7).

In general, commercial bank (or microfinance organization) considers applications from n individuals a_j ($j = 1 \div n$) for the provision of microcredits to them. After verification of the applicants' personal data according to all the above criteria x_i ($i = 1 \div 7$), preliminary data were obtained about each of them in the form of points awarded. To identify the best applicant for a microcredit among the applicants the FIS is offered. For this purpose, considering the preliminary data of the scoring analysis, a cause-effect relation between the quality of the borrower's credit history and his/her level of solvency for a specific date is formulated in fuzzy set notation.

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MEDICAL DIAGNOSIS PROBLEM BY USING NEUTROSOPHIC SOFT SET

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Some types of uncertainties such as the indeterminate information and inconsistent information cannot be handled. Therefore, some new theories are required called neutrosophic logic and neutrosophic sets proposed in 1998 by Florentin Smarandache [10]. Neutrosophic set is capable of dealing with uncertainty, indeterminacy and inconsistent information and is suitable to modeling problems with uncertainty, indeterminacy and inconsistent information in which human knowledge is necessary, and human evaluation is needed. Some definitions and operations on neutrosophic soft set were introduced by Maji [8]. The concept of generalized neutrosophic soft set was presented by Broumi [2]. Broumi and Smarandache defined intuitionistic neutrosophic soft set and established some definitions and operations on these sets [3]. By using neutrosophic soft set and neutrosophic soft set operations, a decision-making method and a group decision making method have been studied in [1, 4, 5, 6, 7, 9]. In this paper our objective is to introduce the matrix representation of the truth part, the indeterminacy part and the falsity part of a neutrosophic soft set. Thus, we introduce the product of two neutrosophic soft sets by means of these matrices and the optimum relation matrix. Then, a decision-making method for the medical diagnosis is established based on the optimum relation matrix; an illustrative example is given to demonstrate the application of the proposed method.

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BOUNDARY HANDLING FOR ORTHOGONAL WAVELETS

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Wavelets are new families of basis functions that can be used to decompose and reconstruct functions defined on the real line. Discrete wavelet transform is used for infinitely long signals. To analyze functions on a closed subset [a, b] of the real line, the basis functions (or the corresponding wavelet transforms) need to be modified - especially those that are used near boundaries of the interval [a, b]. This study presents a way to deal with this problem by introducing a new set of basis functions. In this talk, we present how to handle such cases by constructing appropriate boundary functions and then investigate their properties.

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REVIEW OF RECENT STUDIES ON DETECTION OF CYBERBULLYING WITH MACHINE LEARNING TECHNIQUES

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New interaction opportunities offered by developing technologies, intensive use of social networks, and the chance to be anonymous in online environments make cyberbullying a more serious problem with each passing day. It is known that cyberbullying causes many psychological problems and can negatively affect an individual's whole life. One of the current techniques used to prevent and catch cyberbullying activities is to detect them with machine learning approaches. In this study, 83 studies including the keyword "cyberbullying detection" published between 2017-2021 in the IEEE database were examined by systematic literature review method. As a result of the literature review, the studies were carried out mostly in Twitter, Facebook and Ask.FM social networks, in English, Arabic and Turkish languages, in context of feature selection sentiment analysis, TF-IDF and N-Gram techniques were mostly adopted. Reviewed studies generally conducted with Support Vector Machine, Convolutional Neural Network and Naive Bayes machine learning methods. Review results show that average of F1 rate 77.47, accuracy rate 85.43%, precision 79.85%, and recall 89.87% is in the studies examined. In reviewed papers, it is seen that the number of studies conducted in Spanish, Taiwan and Chinese languages is low and techniques such as KNN, DNN and GAN are less adopted. We believe that the result of the research will shed light on new research in catching cyberbullying with machine learning approaches.

HOMOLOGY THEORY IN THE CATEGORY OF SOFT TOPOLOGICAL

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In this study, by using the covering of soft topological spaces, an inverse system of simplicial complexes is constituted. Built upon these inverse system of simplicial complexes, Cech homology [cohomology] groups of soft topological spaces are defined. It is proved that Cech homology groups constitute a functor from the category of soft topological spaces to the category of groups. Later, axioms of homology theory are checked for this homology groups.

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FUZZY APPROACH TO FORECASTING THE DYNAMICS OF THE SPREAD OF OIL POLLUTION AT SEA

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The presented article proposes an original model based on fuzzy logic to make a decision on predicting the dynamics of the spread of oil pollution at sea as a result of an accident. The aim of the study is to build a fuzzy model that reflects the concentration of oil and the effects of water temperature on the thickness of the oil spill. An intelligent system based on fuzzy theory and implemented in the FUZZY LOGIC subsystem of MATLAB TOOLBOX program package was set up to determine this dependency [2]. The fuzzy logic scheme consists of the following steps for solving the problem [3]:

1. Determining key input and output indicators affecting the process. Setting of term-clusters and its fuzzification [1, 3];
2. Collecting and formulating knowledge about the mutual effect of the indicators. Setting knowledge base [2];
3. Processing of indicators based on fuzzy logical outcomes [1, 3].

Once the necessary knowledge has been obtained from the experts, the following fuzzy model setting up to determine the thickness of the oil stain.

$$D = \langle K, t \rangle \qquad (1)$$

Where *K* and *t* are input, *D* is output variables:

D - thickness of oil slick, $[0 - 8]$, (μm);

K - oil concentration, $[0 - 4]$, *(mg/l);*

t - water temperature, $[3 - 28]$.

For each variable, we define three fuzzy linguistic term sets as follows:

D = {«very small», «small», «average», «large», «very large»};

K = {«very low», «low», «average», «high», «very high»};

t = {«very low», «low», «average», «high», «very high»}.

The model will determine the thickness of the oil spill according to the specific values of the input variables.

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INVERSE AND DIRECT SYSTEMS OF FUZZY SOFT TOPOLOGICAL SPACES

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Let FST be a category of fuzzy soft topological spaces, $\Lambda$is directed sets.

Definition 1. A functor $D: \Lambda^{op} \to FST (D: \Lambda \to FST)$ is called an inverse (direct) system of fuzzy soft topological spaces.

We can write every inverse (direct) system by

$$\{(X_\alpha, E_\alpha, \tau_\alpha)\}_{\alpha\in\Lambda}, \left\{\left(p_\alpha^{\alpha'}, q_\alpha^{\alpha'}\right): (X_{\alpha'}, E_{\alpha'}, \tau_{\alpha'}) \to (X_\alpha, E_\alpha, \tau_\alpha)\right\}_{\alpha<\alpha'} \quad (1)$$

$$\left[\{(X_\alpha, E_\alpha, \tau_\alpha)\}_{\alpha\in\Lambda}, \left\{\left(p_\alpha^{\alpha'}, q_\alpha^{\alpha'}\right): (X_\alpha, E_\alpha, \tau_\alpha) \to \left(X_{\alpha'}, E_{\alpha'}, \tau_{\alpha'}\right)\right\}_{\alpha<\alpha'}\right] \quad (1^*)$$

Let $\prod_{\alpha\in\Lambda}(X_\alpha, \tau_\alpha, E_\alpha)$ be the direct product of fuzzy soft topological spaces. Let τ^* be a fuzzy soft sub topologi in set $\lim\limits_{\leftarrow\alpha} X_\alpha \subset \prod_\alpha X_\alpha$. Then we can set fuzzy soft topological spaces

$$\left(\lim_{\leftarrow\alpha} X_\alpha, \tau^*, \lim_{\leftarrow\alpha} E_\alpha\right) \quad (2) .$$

Theorem 1. Every system in (1) has inverse limit, this limit is unique and equal to fuzzy soft topological spaces (2).

Theorem 2. $\forall r \in 0{,}1$ for $\left(\lim\limits_{\leftarrow\alpha} X_\alpha, \tau_r^*, \lim\limits_{\leftarrow\alpha} E_\alpha\right) = \lim\limits_{\leftarrow\alpha} (X_\alpha, \tau_r, E_\alpha)$

Theorem 3. $\forall e = \{e_\alpha\} \in \underleftarrow{\lim} E_\alpha$ for $\lim\limits_{\leftarrow\alpha} (X_\alpha, \tau_r^*, e) = \lim\limits_{\leftarrow\alpha} (X_\alpha, \tau_r, e_\alpha)$

$\lim\limits_{\leftarrow\alpha} X_\alpha \subset \prod_\alpha X_\alpha$.

Theorem 4. Every system in (1*) has direct limit and this limit is unique.

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THE MOST MAIN IDEA OF LUTFI ZADEH IN ARTIFICIAL INTELLIGENCE

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It is known there are 2 levels of thinking: the retional thinking and the reasonable thinking. The main difference between these levels of thinking consist of that the reasonable thinking operates with other categories- forms of infinity. Einstein and Zadeh both have used reasonable thinking at creating their scientific theory. They both were right because the world is a thing of infinity. Hence, a logic which includes forms of infinity is necessary for its cognition. But if Einstein have worked in cosmological area dealing with space and time then Zade had deal with uncertainties and he worked out new mathematical theory called theory fuzzy sets (FST). Now in our world there are so a lot of uncertainties that the problem its sustainable development begins to play important role in life every man. Therefore, the humanity must be able to confront such sceneries on world arena. For this confrontation the sustainable development of world is very important and therefore it is necessary to know about its uncertainties. FST Zadeh has deal with uncertainties and therefore it can be used by us to predict and recognize world's uncertainties. But as it is known there is a theory of probabilities (PT) created by scientists before Zadeh. What is difference between these two theories, PT and FST of Zadeh? What is the advantage of FST Zadeh? Let's try to answer this question.

PT is based on Kolmogorov's axiomatic where any event is the set of elementary events with the equal probabilities. Furthermore, these elementary events are independent from each other. For example, the play dice has got six faces. All these faces are elementary events with probabilities equaled 1/6. From these elementary events one can create any events. For example, the event the face of dice to has got 3 or 5 points after test. The probability of this event will equal 1/3=1/6+1/6. For dice it is easy to find the probability of any given event. Because here we see from how many elementary events the given event consists. But it is idealization. In real world we say about probability of given events after tests. "How often occur this event?" is the random value. The randomness is connected with the probability. Really, the random value is the "device" for us to find its probability. Information about randomness give us the distribution of probabilities density. There are many distributions and one of them is a normal distribution named by Gaussian distribution. Knowing density of probability will allow us to say about average of random value. Saying about dice again where probability is 1/3 the average of random of appearance these faces from 60 tests equals 60 * 1/3 = 20 and probability is 1/3 = 20/60 too. Probability will be 1 if it does not matter to us which face of the dice takes place after test. The average of the random value will be 60 * 1 = 60. Analogically, probability is equal 1/6 for one face from all faces and average will be 60 * 1/6 = 10. All these can be shown on Gaussian distribution. And it is truth in case of dice. But let's ask will it be truth for reality? Can we see elementary events in some event and be sure them to independent? In his famous book "The Black Swan. The Impact of the Highly Improbable", Nassim Nicholas Taleb has being written that the normal distribution is the "great intellectual lie". Not in such a strict form, Lutfi Zadeh also criticizes the normal distribution figuratively speaking that if you only have a hammer in your hand, then everything seems to be nails to you. There are many "black swans" that is improbable and uncertain events in our life. The tragic terroristic events in 2001 year on September 11 in USA are "black swans". It is necessary to be able to predict them. For this aim we must have a good mathematical theory. And we have such theory. This theory is Lutfi Zadeh's theory of fuzzy sets (FST). In his "fuzzy sets", "Decision making in a fuzzy environment" and others papers Lutfi Zadeh give us scheme how can be decision made by us in environment of the highly improbably and uncertainty.

ON A FUZZY RENEWAL – REWARD MODEL WITH GENERALIZED REFLECTING BARRIER

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Renewal - reward models with barriers are useful tools which are frequently applied in the fields of quantum physics as well as in some problems in various engineering areas. Especially, some problems in inventory theory can be modelled by means of renewal - reward models with a generalized reflecting barrier [1]. However, in inventory models, for instance, while predicting the distribution of the random variables such as demands or inter-arrival times, the entire distribution or some of its parameters can be fuzzy because of the vague information or some other subjective evaluations. Therefore, in this study, a stock control model is investigated as a renewal - reward process with a generalized reflecting barrier when the demands are fuzzy random variables. The aim of this study is to obtain asymptotic expansions for the α-cuts of ergodic distribution and ergodic moments of the considered process which represents a fuzzy inventory model. Particularly, a special case in which the demands have a Weibull distribution with a fuzzy parameter is studied.

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CREATION OF A FUZZY MODEL OF A SOLAR AIR COLLECTOR

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Today, the use of solar energy and the number of solar-powered systems is increasing. Solar air collectors (SAC) are long-lasting, lightweight, inexpensive devices with no corrosion problems. A typical SAC consists of a well-insulated safe, an absorber plate placed inside the safe and a transparent cover.

In the presented work, the operation of the solar air collector is modeled by fuzzy logic based on the data of time, radiation, external temperature, the value of the outlet temperature is forecasted.

The fuzzy inference system includes three input variables: "time (t)", "radiation" (r), "outside temperature" (T_o), and the output variable: "output temperature" (T).

The following table defines three term sets for non-fuzzy input and output variables: for "time" (morning-afternoon-evening), for "radiation" (less-normal-more), and for "outside temperature". (low-normal-high) and for "outlet temperature" (low-normal-high). For each term, the endpoints of the support and the core are shown. Membership functions were chosen symmetrically, in the form of a triangle.

Table 1.

Time (clock) - (morning: 10-11-12, afternoon: 11-13-15, evening: 13-16-18)
Radiation (w/m^2) - (less: 23-310-390, normal: 350-435-520, more: 490-570-650)
Outside temperature (℃) - (low: 28-30.5-33, normal: 30-33-35, high: 33-36-39)
Outlet temperature (℃) - (low: 36-39-42, normal: 40-44-48, high: 46-50-54)

The database consists of nine fuzzy rules. With the built-in logic output system, the outlet temperature is predicted for the SAC.

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ON A TYPE OF LOCAL FUNCTION ON IDEAL TOPOLOGICAL SPACES

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In 1966, the concept of local functions was first presented by Kuratowski [4] and Vaidyanathaswamy [5] gave the notion of ideal topological spaces in 1960. Later, Jankovic and Hamlett [2] developed their works on ideal topological spaces in 1990. They gave the notion of I-open sets and studied topologies by ideals. The notion of Ig -closed sets was given by Dontchev et al. [1] in 1999.The concept of Is*g-closed sets was introduced by Khan and Hamza [3].

In this paper, we define h-local functions and introduce the operation Cl*h and a topology τ*h. Moreover, Is*g-h-closed sets and Ig-h-closed sets are introduced and investigated.

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STABILITY OF AN ELASTIC RING UNDER THE ACTION OF A NON-HYDROSTATIC COMPRESSIVE LOAD

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In the presented work, the stability of a long multilayer elastic shell, composed of different materials and subjected to the action of external pressure, has been investigated. The transferred load is not hydrostatic, i.e. it changes significantly in magnitude and direction [1]. It is known that a ring can have a cross-section consisting of several parts connected by concentric circles. When they are rigidly connected, the ring is considered monolithic and can be considered as ordinary, even if its parts are made of different materials.

Let's define a thin-walled circular ring with radius R, thickness $2h$ and refer it to the polar coordinate system (z,φ) with the origin at the point $z=0$, $-h \le z \le h$, $0 \le \varphi \le 2\pi$. Let us assume that the ring is composed of alternating layers s of different thickness. The thickness of each layer is designated as δ_k. Thus, $\delta_1 + \delta_2 + \ldots + \delta_s = 2h$.

We write the equation of state for the packet as a whole in the form of one equality [2]

$$\varepsilon^v = \frac{\sigma}{E_{k+1}}, a_k \le z \le a_{k+1}, \qquad (1)$$

where σ is the stress, and E_{k+1} $[k = 0,1,\ldots,(s-1)]$ is the modulus of elasticity of the material of the k-th layer. In (1), the notation was introduced

$$a_k = -h + \sum_{j=0}^{k} \delta_j, (\delta_0 = 0).$$

Let us now consider the buckling of the selected ring under the action of a compressive load unevenly distributed over the surface of the form -

$q = q_0 f(\varphi)$, where $f(\varphi)$ is the given sufficiently smooth function, and q_0 is the control loading parameter.

The solution is based on a mixed-type variational method that takes into account geometric nonlinearity, combined with the Rayleigh-Ritz method [3]. By defining the forms for the function $f(\varphi)$ characterizing the non-hydrostatic loading, and by combining the number of layers in a stack, it is possible to achieve a more efficient and complete use of the bearing capacity of the ring and to control the decrease or increase in the critical force.

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EXISTENCE OF NODAL SOLUTIONS TO A CERTAIN NONLINEAR FOURTH ORDER EIGENVALUE PROBLEM

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We consider the following nonlinear eigenvalue problem

$$(p(x)u''(x))'' - (q(x)u'(x))' = \lambda r(x)g(u(x)),\ x \in (0,1), \quad (1)$$

$$u'(0)\cos\alpha - p(0)u''(0)\sin\alpha = 0,\ u(0)\cos\beta + Tu(0)\sin\beta = 0, \quad (2)$$

$$u'(1)\cos\gamma + p(1)u''(1)\sin\gamma = 0, \quad u(1)\cos\delta - Tu(1)\sin\delta = 0, \quad (3)$$

where $\lambda \in R$ is an eigenvalue parameter, $Tu \equiv (pu'')' - qu'$, $p(x)$ is a positive twice continuously differentiable function on $[0,1]$, $q(x)$ is a positive continuously differentiable function on $[0,1]$, $r(x)$ is a positive continuous function on $[0,1]$, $\alpha, \beta, \gamma, \delta$ are real constant such that

$0 \le \alpha, \beta, \gamma, \delta \le \pi/2$. The nonlinear term $g: R \to R$ is continuous and for any $t \ne 0$ satisfies the condition

$$t\, g(t) > 0.$$

Moreover, there exist positive numbers g_0 and g_∞ ($g_0 \ne g_\infty$) such that

$$\lim_{t\to 0} \frac{g(t)}{t} = g_0, \ \lim_{t\to\infty} \frac{g(t)}{t} = g_\infty.$$

The purpose of this note is to determine the value of λ for which there are nodal solutions to problem (1)-(3). We will establish conditions on the ratio $f(t)/t$ at infinity and zero, which guarantee the existence of nodal solutions to this problem. Our approach is based on the results obtained in [1, 2].

As is known (see [1, Theorem 1.2]) the eigenvalues of the linear eigenvalue problem

$$(p(x)u''(x))'' - (q(x)u'(x))' = \lambda r(x)u(x), \ x \in (0,1),$$
$$u'(0)\cos\alpha - p(0)u''(0)\sin\alpha = 0,$$
$$u(0)\cos\beta + Tu(0)\sin\beta = 0,$$
$$u'(1)\cos\gamma + p(1)u''(1)\sin\gamma = 0, \ u(1)\cos\delta - Tu(1)\sin\delta = 0,$$

are nonnegative and simple, and form an infinitely increasing sequence $\{\lambda_k\}_{k=1}^{\infty}$. Moreover, the eigenfunction $u_k(x)$, $k \in \mathrm{N}$, corresponding to the eigenvalue λ_k has exactly $k-1$ simple nodal zeros in $(0,1)$ (by a nodal zero we mean the function changes sign at the zero and at a simple nodal zero, the derivative of the function is nonzero).

The main result of this work is the following theorem.

Theorem 1. Suppose that there exist $k \in \mathrm{N}$ and $s \in \mathrm{N} \cup \{0\}$ such that one of the following conditions is satisfied:

(i) $\dfrac{\lambda_k}{g_\infty} < \lambda < \dfrac{\lambda_{k+s}}{g_0}$;

(ii) $\dfrac{\lambda_k}{g_0} < \lambda < \dfrac{\lambda_{k+s}}{g_\infty}$.

Then problem (1)-(5) has solutions ϑ_m^+ and ϑ_m^-, $m = 1, 2, \ldots, s$, such that ϑ_m^+ has exactly $m-1$ simple nodal zeros in the interval $(0,1)$ and is positive for $0 \neq x$ near 0, ϑ_m^- has exactly $m-1$ simple nodal zeros in the interval $(0, 1)$ and is negative for $0 \neq x$ near 0.

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EXISTENCE AND UNIQUENESS RESULTS FOR THE FIRST-ORDER NON-LINEAR DIFFERENTIAL EQUATIONS WITH MULTI-POINT BOUNDARY CONDITIONS

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The article discusses the existence and uniqueness of solutions for a system of nonlinear ordinary differential equations of the first order with multipoint boundary conditions. The Green function is constructed, and the problem under consideration reduces to equivalent integral equation. Existence and uniqueness of a solution to this problem analyzed using the Banach the contraction mapping principle. Schaefer's fixed-point theorem used to prove the existence of solutions.

Multipoint boundary value problems for ordinary differential equations naturally arise in various fields of natural science. For example, for a dynamical system with n degrees of freedom, exactly n states observed at n different instants of time can be accessed. The mathematical description of such a system leads to a multi-point boundary value problem.

The multipoint boundary value problems for ODEs and their systems are intensively investigated in recent years. This is related with their strong relation with a broad range of applications in different fields of physics and mathematics. As examples for application one can note the vibrations of a uniform cross-section string with composed of N parts of different densities, some problems in the theory of elastic stability [1]. In mathematical formulations these problems are described by the multipoint boundary value problems. Multipoint boundary value problems also arise when discrediting some boundary value problems for partial differential equations.

To date, the multipoint boundary value problems have been mainly studied for second-order differential equations. The study of multi-point boundary-value problems for linear second order ordinary differential equations was initiated by Il'in and Moiseev [2]. Since then, nonlinear multi-point boundary-value problems have been studied by several authors using the Leray-Schauder Continuation Theorem, nonlinear alternatives of Leray-Schauder, coincidence degree theory, and fixed-point theorem in cones.

However, for differential equations of the first order, such problems have been little studied.

In this work for the first time Green function is constructed for the multi-point boundary value problem and the considered problem is reduced to the equivalent integral equations. Then the existence and uniqueness of the solutions is studied using the Banach contraction mapping principle. The existence of the solution is also proved by applying Schaefer's fixed-point theorem.

In this paper, we study the existence and uniqueness of solutions of nonlinear differential equations of the type

$$\dot{x} = f(t, x), \qquad t \in [0, T], \tag{1}$$

with multi-point boundary conditions

$$x(0) + \sum_{i=1}^{m} l_i x(t_i) = \alpha \tag{2}$$

where $l_i, i = 1,2,\ldots,m$ are constant square matrices of order n such that $\|N\| < 1$, $N = \sum_{i=1}^{m} l_i$; $f: [0,T] \times R^n \to R^n$ is a given function; points $t_i, i = 1,2,\ldots,m$ satisfies the condition of $0 = t_0 < t_1 < \ldots < t_m = T$. We denote by $C([0,T]; R^n)$ the Banach space of all continuous functions from $[0,T]$ into R^n with the norm $\|x\| = max\{|x(t)|: t \in [0,T]\}$, where $|\cdot|$ is the norm in the space R^n.

The purpose of this paper is to prove new existence and uniqueness results using Banach contraction principle and Schaefer's fixed-point theorem for problem (1)-(2).

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FUNDAMENTAL SOLUTION OF A THIRD ORDER THREE-DIMENSIONAL COMPOSITE EQUATION

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The paper is devoted to finding a fundamental solution to a boundary value problem for a three-dimensional third order composite equation with nonlocal boundary value conditions.

Consider a three-dimensional composite equation

$$L_1 u_1(x) = \frac{\partial^3 u_1(x)}{\partial x_3^2 \partial x_2} + \frac{\partial}{\partial x_2}\left(\frac{\partial^2 u_1(x)}{\partial x_1^2} + \frac{\partial^2 u_1(x)}{\partial x_2^2}\right) = 0\,,\ x \in D_1 \subset R^3 \qquad (1)$$

in domain D_1 with Lyapunov boundary Γ convex in Ox_3 direction with nonlocal boundary conditions:

$$l_i u = \sum_{m=0}^{1}\sum_{k=1}^{2}\sum_{j,l=1}^{3} \alpha_{ik,jl}^{(m)}(x') \frac{\partial^2 u_k(x)}{\partial x_j \partial x_l}|x_3 = \gamma_m(x') +$$

$$+\sum_{j=1}^{3}\sum_{l=1}^{2}\left[\alpha_{ijl}^{(1)}(x')\frac{\partial u_l(x)}{\partial x_j}|x_3 = \gamma_l(x') + \alpha_{ijl}^{(0)}(x')\frac{\partial u_l(x)}{\partial x_j}|x_3 = \gamma_0(x')\right] +$$

$$+\sum_{m=1}^{2}\left[\alpha_{im}^{(m)}(x')u_m(x',\gamma_m(x')) + \alpha_{im}^{(0)}(x')u_m(x',\gamma_0(x'))\right] = f_i(x'), x' \in S, \qquad (2)$$

$$u(x) = \begin{cases} u_1(x), x \in D_1, x_3 > 0, \\ u_2(x), x \in D_2, x_3 < 0, \end{cases}$$

$$u(x) = f_0(x),\ x \in L = \bar{\Gamma}_1 \cap \bar{\Gamma}_2, \qquad (3)$$

where $S = proj_{x_3} D_1$, Γ_1 and Γ_2 are lower and upper semi-surfaces of boundary Γ respectively defined as $\Gamma_k = \{\xi = (\xi_1, \xi_2, \xi_3): \xi_3 = \gamma_k(\xi'), \xi' = (\xi_1, \xi_2) \in S\}$, functions $\gamma_k(\xi'), k = 1,2$, are twice differentiable; L is an equator between Γ_1 and Γ_2: $L = \bar{\Gamma}_1 \cap \bar{\Gamma}_2$; the coefficients $\alpha_{ijp}^{(k)}(x')$, $\alpha_{ip}^{(k)}(x')$, $i, p = 1,2; j = 1,2,3; k = 0,1$, satisfy Hölder condition in domain S, $f_i(x'), i = 1,2$, and $f_0(x)$ are continuous functions in S and L respectively.

By means of Fourier transformation we obtained a fundamental solution of equation (1) in the form [1]:

$$U(x-\xi) = \frac{i}{(2\pi)^3}\int_{R^3} \frac{e^{i(\alpha, x-\xi)}}{\alpha_2(\alpha_1^2+\alpha_2^2+\alpha_3^2)} d\alpha. \qquad (4)$$

The direct integration of super-singular integral (4) can be done by Hormander ladder [2]. But the authors found another way: to represent the equation in the form $Lu(x) = \Delta \frac{\partial}{\partial x_2} u(x) = 0$ and applying the fundamental solution of three-dimensional Laplace equation we obtained

$$U(x-\xi) = -\frac{1}{4\pi} ln\left|(x_2-\xi_2) + |x-\xi|\right| + C.$$

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ON PROBLEM FOR LINEAR PARABOLIC TYPE OF DIFFERENTIAL EQUATION WITH INTEGRAL CONDITIONS

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The following problem for the parabolic type of equation is considered in present paper: find a continuous function $u = u(x,t)$ in closed domain $\overline{D} = \{0 \le x \le l,\ 0 \le t \le T\}$, which satisfies the equation

$$\frac{\partial u(x,t)}{\partial t} = \frac{\partial}{\partial x}\left(k(x)\frac{\partial u(x,t)}{\partial x}\right) + bu(x,t) + f(x,t), 0 < x < l, 0 < t \le T, \quad (1)$$

integral conditions

$$\int_0^l c_1(x)u(x,t)dx = \mu_1(t), \int_0^l c_2(x)u(x,t)dx = \mu_2(t), 0 \le t \le T \quad (2)$$

and initial condition

$$u(x,0) = \phi(x), 0 \le x \le l \quad (3),$$

here $k(x) \ge k_0 > 0,\ f(x,t),\ c_1(x),\ c_2(x),\ \mu_1(t),\ \mu_2(t),\ \varphi(x)$ - known continuous functions of their arguments, $b -$ real number.

Integral conditions in (2) present certain difficulty in numerical solution of similar problems. In some papers, integral conditions of the form (2) for specific functions $c_1(x)$ and $c_2(x)$ are replaced by local boundary conditions (foe example, [1]). This usually succeeds when the original equation is an equation with constant coefficients.

This work has set the following goal: for a specific function $k(x)=(ax+d)^2$, $a>0$, $d>0$,, determine the class of functions $c_1(x)$, $c_2(x)$, for which problem (1) - (3) can be reduced to a problem for equation (1) with local boundary conditions, construct a difference problem approximating it with the second order of accuracy, and investigate the convergence of the method.

Suppose that $c(x)$ - arbitrary function. Consider the condition

$$\int_0^l c(x)u(x,t)dx=\mu(t).$$

Differentiating this boundary condition with respect to t , we obtain

$$\int_0^l c(x)\frac{\partial u(x,t)}{\partial t}dx=\mu'(t).$$

From here by virtue of (1) from $k(x)=(ax+d)^2$ we have:

$$\int_0^l c(x)\left[\frac{\partial}{\partial x}\left((ax+d)^2\frac{\partial u(x,t)}{\partial x}\right)+bu(x,t)+f(x,t)\right]dx=\mu'(t)$$

or

$$\int_0^l c(x)\frac{\partial}{\partial x}\left((ax+d)^2\frac{\partial u(x,t)}{\partial x}\right)dx=\mu'(t)-b\mu(t)-\int_0^l c(x)f(x,t)dx. \quad (4)$$

Applying twice the formula of integration by parts to the integral on the left-hand side of this equality, after elementary transformations, we get:

$$c(l)(al+d)^2\frac{\partial u(l,t)}{\partial x}-c(0)b^2\frac{\partial u(0,t)}{\partial x}-c'(l)(al+d)^2u(l,t)+c'(0)d^2u(0,t)+$$
$$+\int_0^l\left(c'(x)(ax+d)^2\right)'u(x,t)dx=\mu'(t)-b\mu(t)-\int_0^l c(x)f(x,t)dx. \quad (5)$$

Suppose, that function $c(x)$ be determined from the condition

$$(c'(x)(ax+d)^2)'=\alpha\cdot c(x), \quad (6)$$

where $\alpha-$ real number. This equality defines the Euler equation with respect to a function $c(x)$ of the form:

$$(ax+d)^2c''(x)+2a(ax+d)c'(x)-\alpha c(x)=0. \quad (7)$$

This equation can easily be reduced to a linear differential equation with constant coefficients by substituting $ax+d=e^t$. After this substituting equation (7) takes the form:

$$a^2c''(t)+a^2c'(t)-\alpha\cdot c(t)=0. \quad (8)$$

Corresponding characteristic equation has the form

$a^2k^2+a^2k-\alpha=0.$

Roots of this equation defines as follows:

$$k_1=\frac{-a+\sqrt{a^2+4\alpha}}{2a},\ k_2=\frac{-a-\sqrt{a^2+4\alpha}}{2a}.$$

If $a^2+4\alpha>0,$ then linearly independent solutions of equation (7) can be defined as follows:

$$c_1(x)=(ax+d)^{k_1}, c_2(x)=(ax+d)^{k_2}. \quad (9)$$

If $a^2+4\alpha=0,$ then linearly independent solutions have the form:

$$c_1(x)=\frac{1}{\sqrt{ax+d}}, c_2(x)=\frac{1}{\sqrt{ax+d}}ln(ax+d), \quad (10)$$

and if $a^2+4\alpha<0,$ then we'll get :

$$c_1(x)=\frac{1}{\sqrt{ax+d}}\cos\left(\frac{\sqrt{-a^2-4\alpha}}{2a}\ln(ax+d)\right), c_2(x)=\frac{1}{\sqrt{ax+d}}\sin\left(\frac{\sqrt{-a^2-4\alpha}}{2a}\ln(ax+d)\right). \quad (11)$$

Hence it follows that if the functions $c_1(x)$ and $c_2(x)$ are defined by equalities in (9) or in (10) or (11), then for these functions equality (6) will hold and equality (5) will take the form:

$$c(l)(al+d)^2\frac{\partial u(l,t)}{\partial x}-c(0)d^2\frac{\partial u(0,t)}{\partial x}-c'(l)(al+d)^2u(l,t)+c'(0)d^2u(0,t)=$$
$$=\mu'(t)-(b+\alpha)\mu(t)-\int_0^l c(x)f(x,t)dx. \quad (12)$$

Therefore, if functions $c_1(x)$ and $c_2(x)$ in (2) are determined by equalities (9) or (10, or (11), then integral conditions (2) can be replaced by the following boundary conditions:

$$c_1(l)(al+d)^2\frac{\partial u(l,t)}{\partial x}-c_1(0)d^2\frac{\partial u(0,t)}{\partial x}-c_1'(l)(al+d)^2u(l,t)+c_1'(0)d^2u(0,t)=$$

$$= \mu_1'(t) - (b+\alpha)\mu_1(t) - \int_0^l c_1(x) f(x,t) dx. \qquad (13)$$

$$c_2(l)(al+d)^2 \frac{\partial u(l,t)}{\partial x} - c_2(0) d^2 \frac{\partial u(0,t)}{\partial x} - c_2'(l)(al+d)^2 u(l,t) + c_2'(0) d^2 u(0,t) =$$

$$= \mu_2'(t) - (b+\alpha)\mu_2(t) - \int_0^l c_2(x) f(x,t) dx. \qquad (14)$$

In what follows, instead of problem (1) - (3), consider problem (1), (13), (14), (3) and apply the finite difference method to the solution of this problem.

Under certain conditions, the following theorem is proved

Theorem. The solution of the difference problem corresponding to problem (1), (13), (14), (3) converges to the solution of this problem. Then, following takes place:

$$\left| y_n^j - u(x_n, t_j) \right| \le L\left(h^2 + \tau^2\right), \; n = 0,1,\dots,N, \; j = 0,1,\dots,j_0,$$

where $L > 0 -$ some constant.

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FACTOR ANALYSIS FOR ESTIMATING OF SUSTAINABILITY OF SOSIO-ECONOMIC DEVELOPMENT

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Ensuring environmental safety of socio-economic development requires a transition to a sustainable economic development that respects the compromise between current and future consumption. Compliance with the basic criteria of sustainable development requires that the amount of renewable resources would not decrease over time, and as for non-renewable resources, it is assumed that the rate of their depletion will slow down. In addition, the criteria for sustainable development include the requirement to minimize waste and the condition that environmental pollution in the future would not exceed its current level. Taking into account these criteria will preserve the environment for future generations and will not worsen the ecological living conditions of society today. To analyze the sustainability of socio-economic development, the classification of indicators proposed by the UN Commission on Environmental Protection is used. According to this classification, more than 130 indicators considered are divided into 3 groups: economic, social and environmental [1]. The task is to present these indicators as a linear combination of a relatively small number of hypothetical factors [2]. At the same time, at the first stage, the values of the considered stability indicators Xi j are standardized, i.e. their zij values are calculated, where i=1, ...m, m is the number of indicators, , j=1, ..., n, n is the number of observed years. The values of z are represented as a linear combination of several factors:

$$Z_{i,j} = a_{i1}p_{1j} + a_{i2}p_{2j} + \ldots + a_{ir}p_{rj} ,$$

where a constant coefficients to be determined, and $p_{1j} ,..., p_{rj}$ - are the values of the factors. In matrix form, this can be written as:

$$Z=AP,$$

where *Z*- matrix of normalized primary indicators; *A*- factor mapping matrix, matrix elements are called factor loadings; *P*- matrix of factors for a given period of time.

Generalized factors are determined by the correlation matrix *R* of standardized source data, which is equal to *R= AA*. Knowing the matrix *R,* it is possible to determine the matrix A. Finding the coefficients of the matrix A leads to the selection of factors that have the main part of the variance of the indicators. In practice, the SPSS program was used to identify factors, which determines factors using the principal component analysis.

The use of factor analysis to assess the sustainability of socio-economic development of Azerbaijan has reduced the 24 sustainability indicators described in work to four factors [3]. The matrix of factor loads obtained as a result of orthogonal rotation shows that environmental indicators have the greatest specific weight in all factors. This indicates the priority of environmental indicators in ensuring the sustainable development of society.

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AN OPTIMAL CONTROL PROBLEM WITH A COEFFICIENT FOR A SYSTEM OF SECOND ORDER HYPERBOLIC EQUATIONS

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Let the process be described by the system of differential equations

$$\frac{\partial^2 u}{\partial t^2} - A\frac{\partial^2 u}{\partial x^2} + \upsilon(x)\frac{\partial u}{\partial x} = 0 \qquad (1)$$

In the domain $Q = (0;l)\times(0;T)$, where $u = [u_1(x,t), u_2(x,t)]'$ is a vector-function, A is a constant, positive-definite diagonal matrix of second order, $\upsilon(x) \in V = \left\{\upsilon(x) : \upsilon(x) \in W_2^1[0,l], |\upsilon(x)| \le M, \left|\frac{d\upsilon(x)}{dx}\right| \le M \ a.e. on\ [0,l]\right\}$, M is a given positive number.

Let $u(x,0) = \varphi_0(x), \quad \frac{\partial u(x,0)}{\partial t} = \varphi_1(x), \quad 0 \le x \le l$, (2)

$$u(0,t) = 0, \quad u(l,t) = 0, \quad 0 \le t \le T, \qquad (3)$$

where $\varphi_0(x) \in \left(\overset{0}{W}{}_2^1[0,l]\right)^2, \varphi_1(x) \in (L_2[0,l])^2$ are the given vector-functions.

If the function $\upsilon(x)$ is given, then it is easily proved that problem (1)-(3) has a unique generalized solution from $\left(W_{2,0}^1(Q)\right)^2$.

If $\upsilon(x)$ is an unknown function, then in order to determine $\upsilon(x)$, we give the additional condition

$$u(x,T) = \chi(x), \quad 0 \le x \le l, \qquad (4)$$

Where $\chi(x) \in \left(\overset{0}{W}{}_2^1[0,l]\right)^2$.

We reduce this problem to the following problem find such a function $\upsilon(x)$ $\in V$, that minimizes the functional.

$$J(\upsilon) = \frac{1}{2}\int_0^l \left\| u(x,T;\upsilon) - \chi(x) \right\|_{R^2}^2 dx \to \min , \quad (5)$$

together with the solution of boundary value problem (1)-(3)

There is a close tie between the problems (1)-(4) and (1)-(3), (5); if $\min_{\upsilon \in V} J(\upsilon) = 0,$ then the additional condition (4) is fulfilled.

In the paper we prove a theorem o the existence of optimal control and derive a necessary condition for optimality in the form of a variational inequality.

NORMALIZATION OF DENSITIES OF DISTRIBUTIONS OF OUTPUT PROCESSES OF DYNAMIC SYSTEMS USING HERMITE POLYNOMIAL DECOMPOSITION IN THE ENVIRONMENT OF THE MAPLE

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In the environment of the Maple mathematical package [2], approximate expressions obtained in the form of decomposition by orthogonal Hermite polynomials for the densities [1] of distributions of output processes of dynamical systems determined by integral operators with weights of " unit", "exponential " and "exponential - sinusoidal " types and with input signals in the form of a square of a normal stationary random function [3] are investigated.

The program was compiled based on the following heuristic algorithm:

step1) input of the correlation function of the input signal and the weight functions;

step2) calculation of the correlation matrix to determine the second moments of the output signals through the characteristic function of the 4 - dimensional normal system generated by the input signal;

step3) calculation of the correlation matrix to determine the third moments of the output signals through the characteristic function of the 6 - dimensional normal system;

step4) determination of the fourth moments through an 8 - dimensional normal system;

step5) calculation of asymmetry and kurtosis for the output process of each dynamic system;

step6) definition of expressions for densities based on the calculated characteristics;

step7) construction of comparative density graphs by increasing time values.

The obtained figures allow us to draw practically useful: for the first two types of weight functions, an almost normal distribution is obtained for sufficiently large time values, but for the third type of weight functions, the difference from the normal distribution law is quite significant.

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ON INTERVAL MODELING OF FUZZY UNCERTAINTY

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In the process of solving the control tasks of complex objects often have to deal with the uncertainty of the environment functioning. For example, in economics and management have to make decisions in an uncertain state of the financial assets, economic environment, and so on. The modern development of decision-making under uncertainty is mainly related to the application of the fuzzy set’s theory. The presence in decision-making uncertainty does not allow us to accurately assess the impact of control actions on the objective function. If uncertainty which are exists as in the system itself, so in the observations, can be represented as stochastic processes, so methods of stochastic control are applicable to the such problems. However, there is a relatively large class of problems, the solution of which these methods are ineffective (see, for ex. [2]). Historically, the first and most common is the probabilistic approach to deal with uncertainty. But its use is not always correct, because it requires statistical homogeneity of random events and knowledge of the distribution law, so sometimes introduced nonclassical subjective probability which are not has a partial sense and expresses a person point of view who decide with a deficit of information. Source of uncertainty cannot be random and sometimes can be partially or fully deterministic. At the present time developed quantitative decision-making methods (maximization of expected utility theory of minimax, game theory, etc.) helps to choose the best solution from a set of options only in terms of one particular type of uncertainty or with full certainty. The application of the theory of probability for operating with uncertain values leads to the fact that uncertainty, regardless of its nature, is identified with the accident, while blurry or fuzzy (fuzziness) is the main source of uncertainty in many decision-making processes. Therefore, the account of uncertainty in solving problems largely changes methods of decision making: the principle of representation of input data and model parameters changes, notion of solving the problem and the optimal solution become ambiguous [3]. The system of linear algebraic relations (equations and inequalities) is the simple stand more widely in use mathematical model of most of problems of applied and computational mathematics (see for ex. Dubois D, Prade H., 1980). However, in real problems the values of coefficients and right-hand sides of such may have the indefinite even probabilistic character. The English term “fuzzy sets” suggested by L.Zadeh [1] is visually illustrated by language examples (almost, not quite and so on) and has interesting applications on sphere of artificial intellect in the processes of construction of mathematical models of real situations.

In this work the problems of identification of unknown characteristics of model in case when the coefficients of linear fuzzy relations include these characteristics. They present evident interest in connection with problems of control by complex systems, medical diagnostics and much other ones, in which determing factors often have fuzzy characters, and another time, in generally, they are determined by subjective way.

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ON POSITIVE SOLUTIONS OF SOME NONLINEAR STURM-LIOUVILLE PROBLEMS WITH INDEFINITE WEIGHT

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In this note we consider the following nonlinear Sturm-Liouville problem

$$-y''(x) + q(x)y(x) = r(x)h(y(x)), x \in (0,1), \quad (1)$$

$$\alpha_0 y(0) - \beta_0 y'(0) = \alpha_1 y(1) + \beta_1 y'(1) = 0, \quad (2)$$

where $q(x)$ is a nonnegative continuous function on $[0,1]$, $r(x)$ is a continuous function on $[0,1]$, and there exist $\xi, \eta \in [0,1]$ such that $r(\xi)r(\eta) < 0$, $\alpha_0, \beta_0, \alpha_1, \beta_1$ are real constants such that $|\alpha_0|+|\beta_0|>0,\ |\alpha_1|+|\beta_1|>0, \alpha_0\beta_0 \geq 0$, and $\alpha_1\beta_1 \geq 0$. The function $h: R \to R$ is continuous and there exist h_0 and h_∞ such that

$h(t) = h_0 t + h_1(t)t$ as $t \to 0,$ and $h(t) = h_\infty t + h_\infty(t)t$ as $t \to \infty$,

where

$$\lim_{t\to 0} h_0(t) = 0 \text{ and } \lim_{t\to\infty} h_\infty(t) = 0.$$

Note that the nonlinear problem (1), (2) arises in the modeling of selection-migration in population genetics (see [1, 2]).

In the case when $r(x) \geq 0, x \in [0,1]$ and $r(x)$ is not identically zero on any subinterval of $[0,1]$ problem (1), (2) was considered in [3]. In this paper, it was proved that problem (1), (2) has at least one positive solution in the superliner (i.e. $h_0 = 0$ and $h_0 = \infty$) and (i.e. $h_0 = \infty$ and $h_0 = 0$) sublinear cases.

The main result of this work is the following theorem.

Theorem 1. Let $h_0 = 0$and $h_0 = \infty$ or $h_0 = \infty$ and $h_0 = 0$. Then problem (1), (2) has at least two positive solutions.

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APPLICATION OF FUZZY LOGIC IN MODELING TASKS

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Mathematical modeling is an ideal scientific sign-formal modeling, in which the description of an object is carried out in the language of mathematics, and the study of the model is carried out using certain mathematical methods [2].

The process of formulating a mathematical model is called problem statement [3].

Mathematical modeling can be understood as the process of constructing and studying mathematical models [4].

The model developed and described below will help predict the traffic flows of the city and create, configure and test a management system.

The following modules of the described model have been created:

1. City map display program (Mathlab).

The module uses the input information of the program described above to form a graphical interface and display a fragment of the city map.

2. The program of visual display of vehicles (Mathlab).

The module displays the movement of all vehicles on the roads of the map in accordance with the specified routes. The output information is a pair of values:

A. distance to the forward vehicle

B. speed difference between the car in front and the current one

3. Machine speed control program (Mathlab).

The module gets the result from the previous program. Negative values are regarded as pressing the brake pedal. Positive, like pressing the gas pedal.

At the moment, the stage of modeling the movement of cars has been completed. Fuzzy logic is used to decide whether to press the gas or brake pedal.

Each car, having its own optimal speed and dynamics, simultaneously adjusts to the speed of the car in front. Thus, the use of fuzzy logic allows solving problems of this type with a high degree of reliability.

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INVESTIGATION OF LARGE ELASTIC-PLASTIC DEFORMATIONS USING THE LEFT CAUCHY-GREEN TENSOR

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This work is devoted to the development of a technique for studying finite elastic-plastic deformations. A step-by-step loading procedure is used, which is highly algorithmic. The algorithm for constructing a system of linear algebraic equations, as a rule, is the same at each loading step and has a wide range of applicability. Physical relations are determined using the equation of the second law of thermodynamics for isothermal processes, and the equation of the principle of virtual powers in the actual configuration is taken as the basic equation [1,3]. After linearization, a resolving system of linear equations is obtained, where the unknown is the increment of displacements in the current time layer.

The purpose of this work is to create an algorithm for studying large elastic-plastic deformations and apply it to solving the problems of elastic-plastic deformation of a thick-walled pipe and stretching a round bar.

Let us introduce a global fixed coordinate system with unit vectors $\vec{e_1}$, $\vec{e_2}$, $\vec{e_3}$. In it, we will consider the positions of the deformable body corresponding to the moment of time t_0 and t. Let us introduce tensor of strain measures. It defines finger deformation measure (left Cauchy-Green tensor) [2]: $(B) = (F) \cdot (F)^T$.

In the analysis of the deformation of an elastic-plastic body, the theory of plastic flow is widely used, which is confirmed by direct or indirect two-dimensional or three-dimensional experiments. Based on these experiments, the following conclusions can be drawn.

1. Full deformation in the infinitely close vicinity of a point of the body consists of elastic and plastic parts, and the plastic part is defined as permanent deformation at full unloading.

2. For a wide group of materials, it can be assumed that there is a yield point. For stresses not reaching this limit, the material has a purely elastic behavior. When the yield point is reached, plastic deformation of the body begins.

3. It is assumed that the material has elastic behavior during unloading. It is close to linear.

4. Some materials are considered to be plastically incompressible, that is, they have only elastic volume change.

In this work, a technique is developed for the numerical study of an isotropic material using the left Cauchy-Green tensor. The constitutive relations and the resolving equation are obtained. The algorithm for studying elastic-plastic deformations is applied to solving the problems of elastic-plastic deformation of a thick-walled pipe and tension of a round bar.

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METHODS OF INTELLECTUAL DATA ANALYSIS AND APPLICATIONS

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Considering that we live in the digital age, intelligent data analysis has significant effects from estimating profits in any product, to political issues to make effective decisions in any field. In the article data science, the importance of intellectual data analysis, intellectual analysis data methods and areas of application are covered.

The volume of digital information is growing rapidly in line with modern requirements. The volume of big data and digital information is growing twice almost every two years in the world [1].

Restricting or banning the activities of countries can have a negative impact in the global information space dynamic development in many areas, social activities, interstate information exchange, etc. that we live in an era of ever-expanding information war on the Internet. [2].

Data Science (DS) is a field of science that combines a number of issues which data collection in different formats (structured, unstructured, partially structured) and different indexing schemes (relational, multidimensional, noSQL), preparation for data processing, production of statistics, formation of new data based on experience, forecasting, visualization of results, etc. about. This field of science interacts with such fields as Statistics, Image Recognition, Neural Networks, Machine Learning, Artificial Intelligence, Data Mining, Data Analysis, Database & Data Processing, and Visualization.

The data analysis process is divided into the following stages [1-3]:

- Identify the problem that needs to be solved;
- Data collection;
- Data cleaning;
- Data analysis;
- Creating a model relevant to the issue;
- Visualization.

Artificial intelligence and machine learning methods are applied to data analysis in order to save time and money during the implementation of these processes in a fast-growing array of data - in a large database.

According to machine learning methods, the following forms of intellectual data analysis can be attributed to: Classification; Segmentation; Clustering; Description; Prediction; Dependence (association) analysis.

The following mathematical devices are used in the implementation of the above methods of intellectual analysis:

Statistical methods;

Bayes methods;

Support Vector and Nuclear Methods;

Time series analysis;

Neural Networks;

Fuzzy Logic.

The field of application of intellectual data analysis is very wide. The following are the areas where intellectual analysis methods are applied in practice: Security and public order; Search for information on the Internet; Fraud and risk detection; Logistics; Smart home and smart city; Budget management etc. [3]

Intelligent data analysis helps organizations make the most optimal decisions. Intelligent data analysis will provide the solutions that organizations need to make the right choice, whether it is customer reviews in market or product research, any other issue where data is available, data analysis.

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FUZZY SETS IN A NEW PARADIGM OF LEARNING FROM DATA

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The talk will focus on efficient data-driven modeling associated with the inverse problem and feature extraction. We show how the theories of 1-manifolds and fuzzy (F-) transforms contribute to these delineated areas.

The manifold hypothesis states that the shape of observed data is relatively simple and that it lies on a low-dimensional manifold embedded in a higher-dimensional space.

We contribute to the problem of manifold learning. We show that a space whose topological structure is characterized by a fuzzy partition naturally leads to so called Riemannian spaces or Riemannian manifolds.

ON ONE GENERALIZATION OF TOPOLOGICAL AND SOFT TOPOLOGICAL SPACES

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Soft topological spaces are an important generalization of topological spaces. In this paper, we give the definition of fuzzy topology (cotopology) τ which is a mapping from SS(X, E) to [0, 1] which satisfying some definite conditions. Each soft topological space can be interpreted as a fuzzy soft topological space. Thus, fuzzy soft topological spaces are a generalization of both topological and soft topological spaces. It is shown that an fuzzy topological space gives a parameterized family of soft topological spaces on X. Later we introduce the concepts of base and subbase in fuzzy topological spaces on soft sets and use them to discuss continuous mapping and open mapping. We hope that the results of this study may help in the investigation of fuzzy topological spaces on soft sets.

FAST ALGORITHMS FOR SCHEDULING SWARMS OF ROBOTS AND DRONES WITH MIXED EXACT AND FUZZY CONSTRAINTS

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In the last decade, the unmanned aerial vehicles (UAVs, drones) are widely used in flying communication networks that constitute together sets ("swarms") autonomously flying in 3-dimensional space and carrying out the communications and collaboration missions. Such flying communication systems have emerged in different areas, e.g., military and police operations, weather monitoring, search and evacuation emergency missions, detection of ecological disasters, border surveillance, traffic monitoring, etc.

This lecture considers scheduling problems of practical interest arising in planning and control of drones in which the input data are uncertain, and their uncertainty is *not* of probabilistic nature. In situations where the objective functions and/or constraints are neither deterministic nor probabilistic, the problems may be modelled with the help of fuzzy sets. The aim of this lecture is to present and solve scheduling problems involving both exact (crisp) and fuzzy constraints. Fast (polynomial-time) Artificial Intelligence-based algorithms are described, compared and analyzed.

A VANGUARD APPROACH FOR ENHANCING LEARNING AND TRAINING ACROSS CONTEXTS AND SETTINGS

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Humanoid robotics is an emerging field striving to deploy technological devices capable of resembling and mimicking human form, movement, gestures, and behaviors. The evolving capability of human-like robots to interact with people (HRI) has proved to be contributory to the learning and training process. In this session, Dr. Dan Kohen-Vacs will present his ongoing line of research conducted along with Prof. Gila Kurtz. There, they focus on the affordances of humanoid robots to enhance learning and training processes. Specifically, Dan will present 3 different cases, designed, developed, and deployed during the last three years as part of his prominent line of research focused on innovative technologies used for enhancing learning and training. The 1st case demonstrates deployment efforts consisting of a humanoid robot used as a mediator along with the scenario of a thematic and educational escape-room used for teaching history and preserving national heritage. In the following case, the humanoid robot is deployed as part of an educational scenario aimed to teach adults to use social networks in light of social isolation challenging societies in days of the COVID-19. The recent effort consists of an educational scenario is focused on the Talent Development Model, often used in the world of corporates. Here we address training as required by corporate organizations challenged by new reality in days of the pandemic. Thus, in this recent effort, we explore new ways to enable workers in corporates to experience learning and training anywhere and anytime. We perceive this affordance as important in light of the flexible reality consisting of emergent conditions experienced in days of the novel pandemic. As implied, in these mentioned cases, our research efforts reflect our aspirations to seek innovative ways to scaffold and enhance learning and training supported by humanoid robots while addressing challenges from realistic settings in various fields and contexts.

NEIGHBORHOOD STRUCTURES OF BIPOLAR FUZZY SUPRA TOPOLOGICAL SPACES

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This paper presents the concepts of bipolar fuzzy point and quasi-coincident of bipolar fuzzy point. Since neighborhood structure is a substantial part of topology, we consider the neighborhood structure of a bipolar fuzzy point and generate a bipolar fuzzy supra topology. We also characterize the bipolar fuzzy supra continuity with this structure. Furthermore, we define

the notion of bipolar fuzzy quasi-coincident and discuss certain properties of this concept. Finally, we introduce Q-neighborhood for bipolar fuzzy point.

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IDENTİFİCATİON OF A HARMONİCALLY VARYİNG EXTERNAL SOURCE İN WAVE EQUATİON FROM NEUMANN-TYPE BOUNDARY MEASUREMENT

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In this paper, the identification problem of recovering the spatial source *F* ∈ *L*2(0, *l*) in the wave equation $u_{tt} = u_{xx} + F(x)\cos(\omega t)$, with harmonically varying external source $F(x)\cos(\omega t)$ and with the homogeneous boundary $u(0,t) = u(l,t) = 0, \quad t \in (0,T)$ and initial $u(x,0) = u_t(x,0) = 0, \quad x \in (0,l)$ conditions, is studied. As a measurement output $g(t)$, the Neumann-type boundary measurement $g(t) = u_x(0,t), \quad t \in (0,T)$, at the left boundary $x = 0$ is used. It is assumed that the observation $g(t) \in L^2(0,T)$ may has a random noise. We propose combination of the boundary control for PDEs, adjoint method and Tikhonov regularization, for identification of the unknown

source $F(x) \in L^2(0,l)$. Our approach based on weak solution theory of PDEs and, as a result, allows use of nonsmooth input/output data. Introducing the input-output operatör $\Phi F := u_x(0,t;F)$, $\Phi : L^2(0,l) \to L^2(0,T)$, where $u(x,t;F)$ is the solution of the wave equation with above homogeneous boundary and initial conditions, we first prove the compactness of this operator. This allows to obtain the uniqueness of regularized solution of the identification problem, i.e. the minimum of the regularized cost functional

$$J_\alpha(F) := J(F) + \frac{1}{2}\alpha \|F\|^2_{L^2(0,l)}, \text{ where } J(F) := \|u_x(0,\cdot;F) - g\|^2_{L^2(0,l)}.$$

Then the adjoint problem approach is used to derive a formula for the Fréchet gradient of the cost functional $J(F)$. Use of the gradient formula in the conjugate gradient algorithm (CGA) allows to construct a fast algorithm for recovering the unknown source $F(x)$. A comprehensive set of benchmark numerical examples, with up to 10%noise level random noisy data, illustrate the usefulness and effectiveness of the proposed approach.

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EVALUATION OF THE ACADEMIC PERFORMANCES OF UNIVERSITIES BY THE FUZZY ANALYTICAL HIERARCHY PROCESS

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It is important to raise awareness about the academic performances, research and development activities and other aspects of Turkish Universities in order for education institutions to provide a qualified service [1]. In this study, the importance weights of the monitoring and evaluation criteria of the universities determined by the higher education institution of Turkey (YÖK) will be determined by using the Fuzzy Analytic Hierarchy Process with an algorithm that takes into account the human thinking structure and an algorithm of the ranking problem will be created in the light of these weights. It is thought that this study is important because of evaluating the performances of the universities and observing the progress made compared to the previous year and focusing on the criteria that should be taken into consideration in order for the universities of our country to rank worldwide.

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THEORETICAL BASIS OF ARTIFICIAL NEURAL NETWORKS

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Most areas of human activity require constant improvement. The volume of information and the speed of its change are growing rapidly every year. Processing and managing so much data with human intelligence is ineffective, and traditional computing becomes a labor-intensive process.

Therefore, modern information technologies come to the rescue. In order for the enterprise to function more efficiently, numerous statistical methods and models, as well as specialized software, are created. However, most of the methods have a significant drawback - linearity, that is, the ability to describe most processes with linear dependence, as well as the uniqueness of a stationary solution in a system of linear equations, which makes it not correct enough. To solve weakly formalized problems (requiring time-consuming calculations), it is advisable to use neural networks [1]. These tasks include, for example, forecasting, which is a class of economic problems that can be solved using artificial neural networks. It is their ability to generalize and reveal hidden dependencies within network elements that allows them to cope with such tasks. Therefore, the topic of neural networks is extremely relevant today.

There are many applications of artificial intelligence: decision making, theorem proving, games, creativity, recognition of educated people, data processing in natural language, training networks (Neural networks), etc. Let us dwell in more detail on the consideration of neural network technologies for making management decisions at an enterprise. In today's flow of information, it can be very difficult to make the right decision. Neural network technologies are used to solve problems in which there are no clear algorithms for obtaining the desired results [2].

The purpose of this work is to show that it is possible to use neural networks to make decisions on the search for funding sources and to effectively use neural networks to solve this problem. To achieve this goal, it is necessary to solve the following tasks: - to reveal the essence of artificial intelligence; - train one of the neurosimulators; - to identify, effectively apply and make decisions [3];

The research object is neural networks.

The subject of the research is the development of methods for using neural networks for making management decisions.

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A STUDY ON KIND OF COMPACTNESS ON BIPOLAR SOFT TOPOLOGICAL SPACES

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A bipolar soft set is given by helping not only a chosen set of "parameters" but also set of oppositely meaning parameters called as "not set of parameters". It is known that structure of a bipolar soft set is consisted of by two mappings such that F:E→P(X) and G:⌉E→ P(X) where ⌉E means to the "not set of E". F explains positive information and G explains opposite approximation. Since local finiteness has some applications in many areas, paracompactness is the most important theory in topology using the local finiteness. In this study, we introduce the concept of bipolar soft locally compact and bipolar soft paracompact spaces on bipolar soft topological spaces. Finally, we prove their characterization theorems between them

ON BIPOLAR SOFT METRIC SPACES

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In 2013, Shabir and Naz [1] introduced concept of bipolar soft set and they gave its application in a decision-making problem in the same paper. Recently the idea of the bipolar soft set is getting momentum a number of researchers.

In this paper, first of all, as a new modification of metric spaces, we introduce bipolar soft metric space which is built by two different soft point sets. After that we give some considerable properties of this new concept as

convergence, continuity etc. Finally, some important fixed-point theorems are studied on bipolar soft metric space.

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ZADEH'S FUZZY SETS THEORY IN DISTRIBUTION OF CURRENT IN SEMICONDUCTORS

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The p-n junctions have important role in modern technology. For them it is know there is some distribution of the of current and impurities. We note that this distribution is the fuzzy too and Zadeh's FST can be use by us.

The distribution of electrons and holes for energy levels is described by equation:

$$\Delta P_n|_{x=0} = P_n\,(e^{\frac{eU}{kT}} - 1) \qquad (1),$$

Where x is distance from the p-n border, $\Delta P_n|_{x=0}$ is the surplus concentration of holes in the n-field for x=0; U is external voltage; E is electron's charge ($1{,}6\cdot 10^{-19}$ K).

As going deeply into the n-field, the concentration of holes decreases following the law:

$$\Delta P(x) = P_n|_{x=0}\, e^{-\frac{x}{L_p}} \qquad (2),$$

As know, the equation for holes is expressed as follows:

$$\frac{d^2p}{dx^2} = \frac{p-p_n}{L_p^2} \qquad (3),$$

Where P_n *i*s the concentration of holes in n-field; L_p is diffusion length of holes in n-field.

If P is expressed as a fuzzy function, then (4) turns out to the following differential equation:

$$\frac{d^2\tilde{p}}{dx^2} = \frac{\tilde{p}-p_n}{L_p^2}\,, \qquad (4)$$

Then in accordance with α-cut method, (5) can be represented in from:

$$\frac{d^2[p_1^\alpha, p_2^\alpha]}{dx^2} = \frac{[p_1^\alpha, p_2^\alpha]}{L_p^2} \quad (5)$$

The solution of the equation (6) can be represented in the following from:

$$[p_1^\alpha, p_2^\alpha] = p_n\{[A_1^\alpha, A_2^\alpha]e^{-\frac{x}{L_p}}, [B_1^\alpha, B_2^\alpha]\, e^{-\frac{x}{L_p}}\}, \quad (7)$$

Where $[A_1^\alpha, A_2^\alpha], [B_1^\alpha, B_2^\alpha]$ - are the interval coefficients to be found.

It follows from the condition of distribution concentration for x→∞, that $[B_1^\alpha, B_2^\alpha]$ is equal to the fuzzy zero. In this work the fuzzy zero is represented as:

$$[B_1^\alpha, B_2^\alpha] = [\, - \beta_b\sqrt{-ln\alpha}\,,\ \beta_b\sqrt{-ln\alpha}\,] \quad (8)$$

Where β_b is the parameter of the membership function for the fuzzy zero.

Based on the condition of concentration distribution for $x=Z_n$ (where Z_n is the thickness of the layer with charge of the n-field of the p-n junction):

$$[A_1^\alpha, A_2^\alpha] = [(P_n(e^{\frac{eU}{kT}} - 1) - \beta_b\sqrt{-ln\alpha}e^{\frac{Z_n}{l_p}})e^{\frac{Z_n}{l_p}},$$
$$(P_n(e^{\frac{eU}{kT}} - 1) + \beta_b\sqrt{-ln\alpha}e^{\frac{Z_n}{l_p}})e^{\frac{Z_n}{L_p}}], \quad (9)$$

Then the solution of the equation (5) can be represented in the form:

$$[P_1^\alpha, P_2^\alpha] = [(P_n(1 +(e^{\frac{eU}{kT}} - 1)e^{\frac{x-Z_n}{l_p}} - \beta_b\sqrt{-ln\alpha}e^{\frac{x-2Z_n}{l_p}} - \beta_b\sqrt{-ln\alpha}e^{\frac{x}{l_p}}), (P_n(1 +(e^{\frac{eU}{kT}} - -1)e^{\frac{x-Z_n}{l_p}} + \beta_b\sqrt{-ln\alpha}e^{\frac{x-2Z_n}{l_p}} + \beta_b\sqrt{-ln\alpha}e^{\frac{x}{l_p}})], \quad (10)$$

The surplus concentration of currency carries should be represented as:

$$\widetilde{\Delta P} = \widetilde{P} - P_n \ , \quad (11),$$

Having considered both (10) and (11) the distribution of surplus current can be represented:

$$[\,[\Delta P_n^{1\alpha}, \Delta P_n^{2\alpha}]_{x=0}\,] = [P_n(e^{\frac{eU}{kT}} - 1) - 2\beta_b\sqrt{-ln\alpha}\,,\ P_n(e^{\frac{eU}{kT}} - 1) + 2\beta_b\sqrt{-ln\alpha}e^{\frac{Z_n}{l_p}}], \quad (12).$$

With deeping n-field the surplus fuzzy concentration of holes will be

$$\widetilde{\Delta P}(x) = [\Delta P_n^{1\alpha}, \Delta P_n^{2\alpha}]_{x=0}e^{-\frac{x}{l_p}} - (e^{-\frac{x}{l_p}} - e^{\frac{x}{l_p}})[-\beta_b\sqrt{-ln\alpha}\,, \beta_b\sqrt{-ln\alpha}\,] \quad (13),$$

$$\widetilde{\Delta P}(x) = \cup_\alpha \Delta \widetilde{P^\alpha(x)} \quad (14).$$

It is known for Ge diodes the concentration of holes is $Pn= 5.7*10^9\ cm^{-3}$. Then by using the suggested method we can calculate the fuzzy surplus concentration of holes dependent on X and voltage U. This calculate was made in Azerbaijan State Oil Academy by computer by machine program "Fuzzy Rating" for fuzzy estimates based on FST of Zadeh.

FUZZY EVALUATION OF AIR QUALITY OF AZERBAIJAN

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In this paper with the purpose to analyze the air quality in the country, an approach with the application of intuitionistic fuzzy linguistic tools are proposed. As known air quality is one of the main factors of environmental sustainability. Environmental sustainability Indicators are measured taking into account its different aspects. Intuitionistic Fuzzy Set (IFS) is a very powerful tool for processing uncertain information. IFS are characterized by the degree of membership and the degree of non-membership. Similar to IFS, linguistic intuitionistic fuzzy set (LIFS) is characterized by a linguistic membership degree and a linguistic non-membership degree, respectively. By using the above-mentioned methods, we convert data of main pollution factors of air quality into normalized values in the first step. In the next step we construct the term-sets, taken into account the threshold values. Then, carrying out some calculations according to the proposed methods, in the end we get crisp values. The obtained and analyzed results from intuitionistic linguistic aggregation of air quality index illustrate the state of air quality in Azerbaijan for some years.

A MULTI-CRITERIA DECISION-MAKING METHOD OF TRAPEZOIDAL FUZZY MULTI NUMBERS UNDER SOME AGGREGATION OPERATORS

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Since an element of the universe in fuzzy set has a membership value in [0,1], the membership value is inadequate for providing complete information in some problems as there are situations where each element has different membership values [1,4]. For this reason, a different generalization of fuzzy sets [8], namely multi-fuzzy sets (fuzzy bags) has been introduced by Yager [7] and extended by Miyamoto [4]. Then, Ulucay et al. [6] generalized multi-fuzzy sets to trapezoidal fuzzy multi-numbers (TFM-numbers) on real numbers set R. In this study, we introduce some methods to investigate solution of the multiple criteria decision-making problems given with TFM-numbers. In order to do this, we developed some aggregation operators to aggregate the TFM-information. Also, we propose two new methods for multiple attribute decision making under the trapezoidal fuzzy multi environments. Finally, we apply the proposed approaches to solve the multi-attribute decision making problems and give an analysis table to compare the proposed approaches with existing methods in [1-3,5-6].

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A GRADIENT BOOSTING DECISION TREE ALGORITHM WITH FUZZY DATA

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Decision trees (DT) have an important place in machine learning algorithms. One of the most important aspects of DT is that it can produce explicable rules. DT can be used for classification and regression purposes. Gradient Boosting Decision Trees (GBDT) are generally the most successful among the decision trees used for regression purposes. Gradient descent approach is used in training of the GBDT models. GBDT models have successful applications in many areas. In the literature, there are also variants of GBDT trees integrated with fuzzy logic. In these approaches, simple fuzzy rules are used as the weak learner algorithm used by the GBDT model. Although approaches such as fuzzy inputs and fuzzy partitioning are generally used in fuzzy logic integrated GBDT studies in the literature, it can work with only crisp target variables. However, in this study, a new approach of the GBDT model that can work directly with fuzzy inputs and fuzzy target values is proposed.

Two problems come to the fore in constructing the GBDT algorithm with fuzzy data: first, the decision tree is constructed in case of fuzzy input data, and second, gradient descent step can be performed if the values of the target variable are fuzzy. There are various fuzzy decision tree induction algorithms in the literature for the solution of the first problem. However, there are no decision tree models in the literature for the solution of the second problem, that is, for calculating the gradient of the fuzzy loss function. In this study, such a model is proposed. The loss function used in our study is as follows:

$$L\big(y_i, F(x_i)\big) = \frac{1}{2}(F(x_i) - y_i)^2, i = 1, \dots, n, \quad (1)$$

where $F(x_i)$ is the model output, and y_i is the actual value of the sample x_i. In this case, the gradient is calculated based on the distance between the predicted and actual values of the target variable:

$$\frac{\partial L\big(y_i, F(x_i)\big)}{\partial F(x_i)} = F(x_i) - y_i, i = 1, \dots, n. \quad (2)$$

In case of fuzzy data, fuzzy number arithmetic as well as the distance measurement between the predicted and actual fuzzy values of the target variable is used based on WABL (Weighted Averaging Based on Levels) approach [1]. Experiments of the proposed Fuzzy GBDT algorithm were done on fuzzy simulative datasets. In the experiments, it was seen that the Fuzzy GBDT algorithm produces consistent results.

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ON A PROBABILISTIC SOFT MULTISET AND ITS APPLICATION IN MATRIX

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The concept of soft set theory as a general mathematical tool for dealing with uncertainty was introduced by Molodtsov in 1999. Alkhazaleh and Salleh in 2011 introduced the definitions of a soft multiset as a generalization of Molodtsov's soft set, [2]. In this paper, we incorporate Alkhazaleh and Salleh's soft multiset theory with probability theory, [1] and then propose the notion of probabilistic soft multisets. We define equality of two probabilistic soft multisets, subset, complement of a probabilistic soft multiset, impossible probabilistic soft multiset, certain probabilistic soft multiset with examples. We also introduce the operations of union, intersection, difference and symmetric difference on probabilistic soft multisets.

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AN INVERSE PROBLEM WITH THE NONLOCAL DIRICHLET BOUNDARY CONDITION

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Inverse heat source problems have various important applications in engineering and science. A typical property of this kind of problems is that well-pawedness conditions are not always guaranteed such as existence, uniqueness and stability of their solutions. Particularly, the determination of source terms in the quasi-linear parabolic problem has been extensively explored. For instance, Bushuyev [1] has shown the uniqueness result for the unknown time-dependent right-hand side with explicitly bounded growth rate determined by one additional final measurement. Choulli [2] has considered the determination of a function p from over specified data, where the function p appears in an initial-boundary value problem for the equation $u_t - \Delta \mathrm{u} - \mathrm{pu} + \mathrm{f(u)} = 0$. Dehghan [3] has presented several finite-difference schemes concerning diffusion equation with source control parameter. Lorenzi [5] has studied the stability of an unknown non-linear term in a parabolic equation in dependence on over specified Cauchy-Dirichlet data prescribed on the parabolic boundary of the open set under consideration. A uniqueness theorem has been obtained in the semi linear parabolic equation by Isakov [4] In this paper, we are interested in reconstruction the right-hand side in a quasi-linear parabolic problem. We prove the uniqueness and stability theorem for the inverse source problem and derive some examples to construct the source term for the special case of quasi linear equation.

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ON A SEMI-MAKOVIAN STOCHASTIC PROCESS WITH FUZZY GAMMA DISTRIBUTED INTEFERENCE OF CHANCE

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In this study, a fuzzy semi - Makovian stochastic process is considered. We first obtain the membership function of the fuzzy renewal function when the amount of demand has exponential distribution and interference of chance has a gamma with fuzzy parameters. Under this assumption the fuzzy ergodic distribution of this process is obtained. Also, some numerical results are obtained with the use of this membership function.

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ON THE SOLVABILITY OF THE INVERSE BOUNDARY-VALUE PROBLEM FOR AN EQUATION OF THE THIRD ORDER WITH INTEGRAL CONDITIONS

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In the region defined by $D_T = \{(x,t): 0 \le x \le 1,\ 0 \le t \le T\}$, we consider the inverse boundary-value problem for the equation [1]

$$u_{ttt}(x,t) - u_{txx}(x,t) + u_{tt}(x,t) - \alpha u_{xx}(x,t) = a(t)u(x,t) + b(t)u_t(x,t) + f(x,t) \quad (1)$$

with the initial conditions

$$u(x,0) = \varphi_0(x), \quad u_t(x,0) = \varphi_1(x), \quad u_{tt}(x,0) = \varphi_2(x) \quad (0 \le x \le 1), \quad (2)$$

the boundary conditions

$$u_x(0,t) = u_x(1,t) = 0 \quad (0 \le t \le T), \quad (3)$$

and the additional integral conditions of the second kind

$$u(0,t) + \int_0^1 \omega_1(x)dx = h_1(t), \quad u(1,t) + \int_0^1 \omega_2(x)dx = h_2(t) \quad (0 \le t \le T), \quad (4)$$

where α $(0 < \alpha < 1)$ is a given number, $f(x,t)$, $\varphi_i(x)$ $(i = 0,1,2)$, $\omega_i(x)$, $h_i(t)$ $(i = 1,2)$ are given functions, $u(x,t)$, $a(t)$, and $b(t)$ are desired functions.

We denote

$$\tilde{C}^{(2,3)}(D_T) = \{u(x,t), u_x(x,t), u_{xx}(x,t), u_t(x,t), u_{tx}(x,t), u_{txx}(x,t), u_{tt}(x,t), u_{ttt}(x,t) \in C(D_T)\}.$$

Definition. The classical solution of the inverse boundary-value problem (1)-(4) is the triplet $\{u(x,t), a(t), b(t)\}$ of functions $u(x,t) \in \tilde{C}^{(2,3)}(D_T)$, $a(t) \in C[0,T]$, and $b(t) \in C[0,T]$ satisfying the equation (1) in D_T, the condition (2) in $[0,1]$, and the conditions (3), (4) in $[0,T]$.

To study the solvability of the inverse problem, we first reduce the considered problem to an equivalent problem in a certain sense. Using the Fourier method, the equivalent problem is reduced to solving a system of integral equations. With the help of the method of compressed mappings, the existence and uniqueness of the solution of a system of integral equations, which is also the only solution to an equivalent problem, are proved.

Using equivalence, it is possible to prove the existence and uniqueness of the classical solution of the original problem.

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HOMOTOPİC SETS OF SOFT TOPOLOGİCAL SPACES

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Definition1: If there exists a soft continuous mapping

$$(F,\phi)(x_e;0_n)=(f,\varphi)(x_e)=f(x)_{\varphi(e)}$$
$$(F,\phi)(x_e;1_n)=(g,\psi)(x_e)=g(x)_{\psi(e)}$$

satisfying the following conditions

$$(F,\phi):(X,\tau,E)\times(I,\tau_I,N)\rightarrow(X',\tau',E')$$

then the mapping (F,ϕ) is called a soft homotopy and the mappings $(f,\varphi),(g,\psi)$ are said to be homotopic mappings and are shown as $(f,\varphi)\sim(g,\psi)$.

Theorem1: The homotopy relation of soft topological spaces is equivalence relation and is invariant with respect to superposition.

Theorem2: For every soft continuous mapping

$$(f,\varphi):(X,\tau,E,x_e^0)\rightarrow(Y,\tau',E',y_{e'}^0)$$

the sequence $(X,\tau,E,x_e^0)\rightarrow(Y,\tau',E',y_{e'}^0)\rightarrow C(f,\varphi)$ of soft topological spaces is coexact.

1. C.Gunduz, S.Bayramov, Algebraic structures on fuzzy homotopy sets, Proceedings of the Jangjeon Mathematical Society, 2006, 9(2), p.161-173.
2. Bayramov S., Gunduz C., Mdzinarishvili L., Singular homology theory in the category of soft topological spaces, Georgian Math.J. 2015,22(4), 457-467.

BOUNDARY PROBLEM FOR THE THIN PLATES BENDING EQUATION WITH THE INTEGRAL CONDITIONS

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Consider for the thin plates bending equation [1],

$$u_{tttt}(x,t) + 2u_{ttxx}(x,t) + u_{xxxx}(x,t) = a(t)u(x,t) + f(x,t) \quad (1)$$

in the domain

$$D_T = \{(x,t): 0 \le x \le 1, 0 \le t \le T\}$$

a boundary problem with non-local conditions

$$u(x,0) = \int_0^T P_0(t)u(x,t)dt + \varphi_0(x)$$

$$u_t(x,T) = \int_0^T P_1(t)u(x,t)dt + \varphi_1(x)$$

$$u_{tt}(x,0) = \int_0^T P_2(t)u(x,t)dt + \varphi_2(x)$$

$$u_{ttt}(x,T) = \int_0^T P_3(t)u(x,t)dt + \varphi_3(x)$$

$$(0 \le x \le 1) \quad (2)$$

with boundary conditions

$$u_x(0,t) = 0\,, u_{xx}(1,t) = 0\,, u_{xxx}(0,t) = 0 \quad (0 \le t \le T) \quad (3)$$

with non-local integral conditions

$$\int_0^1 u(x,t)dx = 0 \qquad (0 \le t \le T) \quad (4)$$

where $a(t), f(x,t), P_i(t)(i = \overline{0,3}), \varphi_i(x)(i = \overline{0,3})$ - given functions, $u(x,t)$ unknown function.

Definition

We call $u(x,t)$ the classic solution of boundary value problem (1)-(4)

If the following conditions are satisfied:

the function $u(x,t)$ is continuous in D_T together with all its derivatives,

$$u_x(x,t)\ ,u_{xx}(x,t)\ ,u_{xxx}(x,t)\ ,u_{xxxx}(x,t)$$
$$u_t(x,t)\ ,u_{tt}(x,t)\ ,u_{ttt}(x,t)\ ,u_{tttt}(x,t)$$
$$u_{ttxx}$$

the problem (1)-(4) is satisfied in the ordinary sense.

In the paper first, the initial problem is reduced to the equivalent problem, for which the theorem of existence and uniqueness of solutions is proved. Then, using these facts, the existence and uniqueness of the classical solution of initial problem is proved.

1. Y.N.Rabotnov, Mechanics of a Deformable Solid. Science, M. 1988

A PROBLEM RELATED WITH JACKSON-BERNSTEIN CLASSIC THEOREM FOR PERIODIC FUNCTIONS

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This paper is devoted to the analogue of Jackson-Bernstein classic theorem on the curves in the complex plane in integral metric. In a uniform metric this matter in the form of a problem was formulated by J.Walsh. The similar problem on the curves in a complex plane in the integral metric was not studied enough and, in this formulation, it is considered for the first time.

In the paper we consider the analogue of a problem J. Walsh [1] on closed curves in a complex plane in the metric L_p related with Jackson-Bernstein classic theorem for periodic functions from the class $f \in Lip_{[0,2\pi]}\alpha\ (0<\alpha<1)$ that affirms for $f \in Lip_{[0,2\pi]}\alpha\ (0<\alpha<1)$, it is necessary and sufficient the fulfillment of the condition

$$E_n\left(f;[0,2\pi]\right)=\inf_{p_n}\left\|f-P_n\right\|_{C[0,2\pi]}\le const\cdot n^{-\alpha}\ .$$

Direct theorems of polynomial approximation on closed curves in a complex plane in the metric L_p are considered.

We need some results from [2] where a survey of basic stages of investigations related with J. Walsh problem in the metric C is given.

Theorem 1. If the curve $\Gamma \in M$ and $f \in E_p^*(G)$ $(p \geq 1)$, then for each natural n there exists a polynomial P_n such that

$$\| f - P_n \|_{L_p(\Gamma)} \leq const\, \omega_p^{(2)}\left(f, \frac{1}{n} \right)_\Gamma .$$

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ON AN INVERSE PROBLEM FOR THE SIXTH-ORDER BOUSSINESQ EQUATION

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Consider the equation [1]

$$u_{tt}(x,t) - u_{xx}(x,t) - u_{ttxx}(x,t) + u_{xxxx}(x,t) + u_{ttxxxx}(x,t) = b(t)g(x,t) + f(x,t) \quad (1)$$

in the domain $D_T = \{(x,t): 0 \leq x \leq 1,\ 0 \leq t \leq T\}$ and set for it the inverse boundary value problem with initial conditions

$$u(x,0) = \varphi(x),\ u_t(x,0) = \psi(x)\ (0 \leq x \leq 1), \quad (2)$$

Neumann-type boundary conditions

$$u_x(0,t) = u_x(1,t) = u_{xxx}(0,t) = u_{xxx}(1,t) = 0 \quad (0 \leq t \leq T) \quad (3)$$

and an additional condition

$$\alpha_1 u(0,t) + \alpha_2 u(1,t) = h(t) \quad (\ 0 \leq t \leq T), \quad (4)$$

where α_1, α_2 – fixed numbers, $f(x,t), g(x,t)$, $\varphi(x), \psi(x)$, $h(t)$ – are given functions, $u(x,t)$ and $b(t)$ – functions you are looking for.

Denote by:

$$\tilde{C}^{4,2}(D_T) = \{u(x,t) : u(x,t) \in C^2(D_T), u_{xxxx}(x,t), u_{ttxxxx}(x,t \in C(D_T)\}$$

Definition. The pair functions $\{u(x,t), b(t)\}$ is said $u(x,t) \in \tilde{C}^{4,2}(D_T)$ and $b(t) \in C[0,T]$,to be a classical solution to the inverse boundary problem (1)-(4). satisfying the equation (1) in D_T, condition (2) in $[0,1]$ and conditions (3)-(4) in $[0,T]$, .

First, the original problem is reduced to an equivalent problem, for which the theorem of existence and uniqueness of the solution is proved. Further, using these facts, the existence and uniqueness of the classical solution of the original problem are proved**.**

1. 1. G. Schneider, C.W. Eugene, Kawahara dynamics in dispersive media, Physica. D. 152–153 (2001) 384–394.

THE MOST MAIN IDEA OF LUTFI ZADEH

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To cognate real world it is necessary to use Zadeh's Fuzzy sets theory (FST). But as it is known there is a theory of probabilities (PT) created by scientists before Zadeh. What is difference between these two theories, PT and FST of Zadeh? What is the advantage of FST Zadeh? Let's try to answer this question.

PT is based on Kolmogorov's axiomatic where any event is the set of elementary events with the equal probabilities. Furthermore, these elementary events are independent from each other. For example, the play dice has got six faces with probabilities equaled 1/6. From these elementary events one can create any events. For example, the dice has got 3 or 5 after test. The probability of this event will equal 1/6+1/6=1/3. For dice it is easy to find the probability of any given event. Because here we see from how many elementary events the given event consists. But it is idealization. In real world there is not such idealization as in dice. We cannot see elementary events inside event. Therefore, we don't know apriori probability of events as in case of dice. We say about probability of given event of real world after tests. The results of these tests are random value. The randomness is the “device” for us to find its probability. Information about randomness give us to know the distribution of probabilities density. There are many distributions and one of them is a normal distribution named by Gaussian where central limit theorem (CLT) must take place.

But let’s ask will it be truth for reality? Can we see elementary events in some event and be sure them to independent? In his famous book “The Black Swan. The Impact of the Highly Improbable”, Nassim Nicholas Taleb has being written that the normal distribution is the “great intellectual lie” that is truth for dice but not truth for real world.

Saying about dice again if the probability is 1/6 then the average of random from 60 tests equals 60 * 1/6 = 20. If it is 1/3 then 60 * 1/3 = 20. All these cases of dice can be shown well on the Gaussian distribution. But in real world is it so ideal?

Really, the investigations of many scientists have demonstrated (for example in Moscow State University Shnoll and etc.) in studying fluctuations of macriscopic phenomena of various behavior (chemical, biological, radiation) there are strange law in their distribution not explained by PT and Gaussian distribution but can be explained by FST Zade in our opinion.

The most main idea of Zade is to see in these fluctuations are the "device" to observe "fuzziness", to say that not only elementary but focal events, that are depend each with other, are in each event.

CONTENT

Kočinac Lj.D.R
SELECTIVE PROPERTIES IN FUZZY AND SOFT TOPOLOGICAL SPACES 7
Alexey Averkin
A MODERN APPROACH TO FUZZY SYSTEMS
AS A BRIDGE BETWEEN CONNECTIONIST AND SYMBOLIC SYSTEMS 7
Alexander Sostaks
FUZZY RELATIONS AS THE BASE FOR FUZZIFICATION OF DIFFERENT
MATHEMATICAL STRUCTURES.. 9
Cagdas Hakan Aladag
MODEL EVALUATION CRITERION BASED ON MEMBERSHIP VALUES 10
Imanov G., Murtuzaeva M., Aliyev A.
COMPLEX FUZZY EVALUATION OF SOCIAL CAPITAL 11
Gurbanov F. I., Mamedova N.G.
FUZZY DIFFERENTIAL EQUATIONS IN DIFFERENT METRIC SPACES.............. 12
Mikayil Sadigzade, Efendi Nasiboglu
COMPARISON OF VARIOUS MACHINE LEARNING METHODS FOR
DETECTING CYBERBULLYING IN TWITTER MESSAGES 13
Ahmet Alturk, Fritz Keinert[2]
REGULARITY PROPERTIES OF BOUNDARY FUNCTIONS
FOR BIORTHOGONAL WAVELETS.. 14
Aliyev E.R.[1], Rzayev R.R.[1], Aliev E.R.[2]
EVALUATION OF MICROCREDIT BORROWERS USING SOME SCORING
AND FUZZY METHODS OF THE RELEVANT DATA ANALYSIS......................... 15
Coshkun Erdem A., Gunduz Aras Ch.
MEDICAL DIAGNOSIS PROBLEM BY USING NEUTROSOPHIC SOFT SET 16
Ahmet Alturk[1], Fritz Keinert[2]
BOUNDARY HANDLING FOR ORTHOGONAL WAVELETS.............................. 18
Atajan Rovshenov, Mikayil Sadigzade, Efendi Nasiboglu
REVIEW OF RECENT STUDIES ON DETECTION OF CYBERBULLYING WITH
MACHINE LEARNING TECHNIQUES 19
Abdullayev Sabuhi, Bayramov Sadi
HOMOLOGY THEORY IN THE CATEGORY OF SOFT TOPOLOGICAL 20
Ahmadova R.Y[1], Shikhlinskaya R.Y[2].
FUZZY APPROACH TO FORECASTING THE DYNAMICS OF THE SPREAD
OF OIL POLLUTION AT SEA 20

Veliyeva K.M.[1], Cigdem Gunduz Aras[2], Bayramov S.A.[1]
INVERSE AND DIRECT SYSTEMS OF FUZZY SOFT TOPOLOGICAL SPACES 22
Isayeva E.A., Aliyeva A.M.
THE MOST MAIN IDEA OF LUTFI ZADEH IN ARTIFICIAL INTELLIGENCE........ 23
Khaniyev T.[1], Gever B.[2]
ON A FUZZY RENEWAL – REWARD MODEL WITH GENERALIZED REFLECTING BARRIER 24
Shikhlinskaya R.Y., Bakhishov N.M., Panahli N.N.
CREATION OF A FUZZY MODEL OF A SOLAR AIR COLLECTOR...................... 25
Ahu Acikgoz[1], T.Noiri[2], Busra Golpinar[1]
ON A TYPE OF LOCAL FUNCTION ON IDEAL TOPOLOGICAL SPACES........... 26
Mekhtiev M.F., Fatullayeva L.F., Huseynli M.E
STABILITY OF AN ELASTIC RING UNDER THE ACTION OF A NON-HYDROSTATIC COMPRESSIVE LOAD 27
Aliyev Z. S., Panahov M.Q
EXISTENCE OF NODAL SOLUTIONS TO A CERTAIN NONLINEAR FOURTH ORDER EIGENVALUE PROBLEM 28
Sharifov Y.A., Jabrailov Sh.I., Mammadova N.B.
EXISTENCE AND UNIQUENESS RESULTS FOR THE FIRST-ORDER NON-LINEAR DIFFERENTIAL EQUATIONS WITH MULTI-POINT BOUNDARY CONDITIONS 30
Mustafayeva Y.Y., Aliyev N.A.
FUNDAMENTAL SOLUTION OF A THIRD ORDER THREE-DIMENSIONAL COMPOSITE EQUATION 32
Khankishiev Z.F., Abbasova A. Kh.
ON PROBLEM FOR LINEAR PARABOLIC TYPE OF DIFFERENTIAL EQUATION WITH INTEGRAL CONDITIONS... 33
Abbasova Sh.A., Mirzayev F.A., Khuliyeva N.A.
FACTOR ANALYSIS FOR ESTIMATING OF SUSTAINABILITY OF SOSIO-ECONOMIC DEVELOPMENT 36
Kuliyev H.F.[1], Huseynova T.M.[2]
AN OPTIMAL CONTROL PROBLEM WITH A COEFFICIENT FOR A SYSTEM OF SECOND ORDER HYPERBOLIC EQUATIONS.. 38
Gasimov G.R., Rzayev E., Aghayeva M.H.
NORMALIZATION OF DENSITIES OF DISTRIBUTIONS OF OUTPUT PROCESSES OF DYNAMIC SYSTEMS USING HERMITE POLYNOMIAL DECOMPOSITION IN THE ENVIRONMENT OF THE MAPLE 39
Quliyev R.M., Mirzayev F.A., Karimova Sh.M.
ON INTERVAL MODELING OF FUZZY UNCERTAINTY 40

Panahov M. Q.
ON POSITIVE SOLUTIONS OF SOME NONLINEAR STURM-LIOUVILLE PROBLEMS WITH INDEFINITE WEIGHT 42
Novruzova G. S.
APPLICATION OF FUZZY LOGIC IN MODELING TASKS 43
Mekhtiev M.F., Fatullayeva L.F., Rustamova N.F.
INVESTIGATION OF LARGE ELASTIC-PLASTIC DEFORMATIONS USING THE LEFT CAUCHY-GREEN TENSOR........ 44
Gasumov V.A., Guluzadeh D.A., Mammadova V.X.
METHODS OF INTELLECTUAL DATA ANALYSIS AND APPLICATIONS 46
Irina Perfilieva
FUZZY SETS IN A NEW PARADIGM OF LEARNING FROM DATA 48
Bayramov Sadi
ON ONE GENERALIZATION OF TOPOLOGICAL AND SOFT TOPOLOGICAL SPACES 48
Eugene Levner
FAST ALGORITHMS FOR SCHEDULING SWARMS OF ROBOTS AND DRONES WITH MIXED EXACT AND FUZZY CONSTRAINTS 49
Dan Kohen-Vacs, Gila Kurtz
A VANGUARD APPROACH FOR ENHANCING LEARNING AND TRAINING ACROSS CONTEXTS AND SETTINGS........ 49
Malkoch Hami[1], Pazar Varol Banu[2]
NEIGHBORHOOD STRUCTURES OF BIPOLAR FUZZY SUPRA TOPOLOGICAL SPACES 50
Pektas B.[1], Chatak M.[2]
IDENTİFİCATİON OF A HARMONİCALLY VARYİNG EXTERNAL SOURCE İN WAVE EQUATİON FROM NEUMANN-TYPE BOUNDARY MEASUREMENT ... 51
Hayrunnisa Ergin, Efendi Nasibov
EVALUATION OF THE ACADEMIC PERFORMANCES OF UNIVERSITIES BY THE FUZZY ANALYTICAL HIERARCHY PROCESS 53
Behsati N.F
THEORETICAL BASIS OF ARTIFICIAL NEURAL NETWORKS 53
Bayramov Sadi[1], Chigdem Gunduz Aras[2]
A STUDY ON KIND OF COMPACTNESS ON BIPOLAR SOFT TOPOLOGICAL SPACES 55
Hande Poshul[1], Chigdem Gunduz Aras[2], Sadi Bayramov[3]
ON BIPOLAR SOFT METRIC SPACES........ 55

Isayeva E.A., Aliyeva A.M.
ZADEH'S FUZZY SETS THEORY IN DISTRIBUTION OF CURRENT IN SEMICONDUCTORS 56
Murtuzaeva M., Pur Riza S.
FUZZY EVALUATION OF AIR QUALITY OF AZERBAIJAN 58
Kesen D., Deli I.
A MULTI-CRITERIA DECISION-MAKING METHOD OF TRAPEZOIDAL FUZZY MULTI NUMBERS UNDER SOME AGGREGATION OPERATORS 59
Nasibov E.N., Nasiboglu R.A.
A GRADIENT BOOSTING DECISION TREE ALGORITHM WITH FUZZY DATA .. 60
Coshkun Erdem A.
ON A PROBABILISTIC SOFT MULTISET AND ITS APPLICATION IN MATRIX ... 61
Coshkun Erdem A.
AN INVERSE PROBLEM WITH THE NONLOCAL DIRICHLET BOUNDARY CONDITION 62
Rovshan Aliyev[1], Urfan Aliyev[2]
ON A SEMI-MAKOVIAN STOCHASTIC PROCESS WITH FUZZY GAMMA DISTRIBUTED INTEFERENCE OF CHANCE 63
Iskenderov N.Sh., Alizade U.S.
ON THE SOLVABILITY OF THE INVERSE BOUNDARY-VALUE PROBLEM FOR AN EQUATION OF THE THIRD ORDER WITH INTEGRAL CONDITIONS .. 64
Jafarli V.F.
HOMOTOPİC SETS OF SOFT TOPOLOGİCAL SPACES 65
Mammadova Y. V., Mehraliyev Y.T.
BOUNDARY PROBLEM FOR THE THIN PLATES BENDING EQUATION WITH THE INTEGRAL CONDITIONS 66
Mamedkhanov J.I.[1], Dadashova İ.B.[2]
A PROBLEM RELATED WITH JACKSON-BERNSTEIN CLASSIC THEOREM FOR PERIODIC FUNCTIONS 67
Farajov A.S.
ON AN INVERSE PROBLEM FOR THE SIXTH-ORDER BOUSSINESQ EQUATION 68
Isayeva E.A., Aliyeva A.M.
THE MOST MAIN IDEA OF LUTFI ZADEH 69

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