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ABSTRACTS

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THE NECESSITY OF ASSESSMENT CRITERIA IN SELECTING FOREIGN LANGUAGE TEXTBOOKS

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In the educational sphere, it has long been a challenge to select textbooks that correctly fit the needs of target groups. The market offers quite a large variety of textbooks, however, there are no assessment criteria for textbook analysis in Georgian reality. I tried to answer the following questions in the given paper:

At what extent does a successful lesson depend on the correctly selected foreign language textbook?

What are the main criteria that a textbook should meet it to be used in teaching a foreign language?

To perform accurate analysis of foreign language textbooks operating at the Language Center of Batumi State University, we selected a working group of 46 teachers who were acquainted with the textbook assessment criteria approved in Europe.

(„Mannheimer Gutachten zu ausgewählten Lehrwerken Deutsch als Fremdsprache“ (1977) from Engel/Krumm; „Brünner Kriterienkatalog zur Beurteilung von Lehrwerken für den Deutschunterricht in tschechischen Grundschulen und Gymnasien“ (1977) from Jenkins; „Stockholmer Kriterienkatalog zur Beurteilung von Lehrwerken des Faches Deutsch als Fremdsprache in den nordischen Ländern“ (1985), - Universität Uppsala/ Goethe-Institut Stockholm, „Deutsch für ausländische Arbeiter. Gutachten zu ausgewählten Lehrwerken“ (1986), from Chun Ohk Kim; „Abdruck verschiedener Kriterienlisten“ (1994) from Kast; „Lehrwerke für Deutsch als Fremdsprache“ (1998) from Schloßmacher).

The above-mentioned materials were elaborated to create textbook assessment criteria based on the unified European framework requirements that were presented to the University administration for publicity

Therefore, the purpose of the given report was to elaborate the assessment criteria for foreign language textbooks used in Batumi State University. It's worth mentioning that such criteria are not actually available in Georgian educational space nowadays.

MODERN LEXICOGRAPHY AND TECHNOLOGIES

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Dictionaries have been written for a long time and accumulated experiences have changed the shape of the dictionary rather than the structure of it.

Today, when the development of lexicography is interconnected with technologies, printed dictionaries have almost been replaced by online dictionaries that allow for quick access to the word. Based on today's technological achievements, when serious work is done to provide online text translation, Georgian-Turkish online space is limited to dictionaries such as: translate.ge, Glosbe, targmne.com and etc.

Which according to users are more likely to be illogical and misleading? The accumulated lexicographical experiences have altered formed and content structure of dictionaries: In the second half of the 20th century, except for the description and comparison of linguistic systems, dictionaries were found to contain the description of cultural background beyond the language for the purpose of adequate translation.

On the background of the development of modern world lexicography, together with efforts of lexicographers and technologists, taking into consideration the word polysemy and grammar-semantic formalities, it is necessary to develop Georgian-Turkish Cultural electronic dictionaries, which provides convenient conditions of fast and adequate translation.

ASYMPTOTIC BEHAVIOR OF ERGODIC DISTRIBUTION OF THE RENEWAL REWARD PROCESS WITH A STRONGER SUBEXPONENTIAL DISTRIBUTED COMPONENT

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In present study, renewal reward process $X(t)$ with a heavy tailed distributed rewards having finite variance is considered. The asymptotic expansions as $\beta = S - s \rightarrow \infty$ for the ergodic distribution of the process

$W_\beta(t) \equiv \frac{1}{\beta}(X(t) - s)$, based on the main result of the study Geluk and

Frenk (Renewal theory for random variables with a heavy tailed distribution and finite variance. Statistics and Probability Letters, 2011, 81: 77–82), are obtained. Moreover, special case, when reward sizes has Pareto distribution with parameter $\alpha > 2$ is considered.

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DECISION-MAKING ON ASSESSMENT OF HIGHER EDUCATION INSTITUTIONS UNDER UNCERTAINTY

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The issues of assessment of higher education institutions (HEI) and the results of their activities lately become particularly important. Last year, the amendments to the Budget Code of Ukraine were introduced, according to which the distribution of funding between HEI should be based on the results of their educational and scientific activities. It is also planned to create apportionment formula, which should be approved by the Cabinet of Ministers of Ukraine. Similar problems arise when solving the problems of funding apportionment for scientific research, giving the status of national institutions and in some other cases. The apportionment formula in such cases actually sets the objective function in the multidimensional optimization problem. However, for these problems there are no clearly defined criteria of optimality, and the data used for the evaluation may contain statistical and other errors. There is also the problem of the admissibility of using common indicators and

assessment methods for different fields of knowledge and different sciences.

In this regard, comprehensive solutions are needed to determine the measurement objectives, to form a system of relevant and reliable indicators and criteria, as well as to develop the information system for collecting and storing the statistical data required for the calculations. This last system should be united with other state information systems and information systems of HEI. Some criteria for assessing students' quality and tuition fee are proposed and analyzed. Also some indicators of statistical reporting were proposed, which are needed to form criteria and ensure compatibility of data with the indicators which are collected by leading international bases, such as UNESCO Institute of statistics, OECD and World Bank bases.

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ON FOURIER TRIGONOMETRIC SERIES

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Below we suppose that $T = [-\pi, \pi]$ and functions $f : \mathbb{R} \rightarrow \mathbb{R}$ are 2π -periodic. For $f \in L(T)$, by $\sigma[f]$ and $\bar{\sigma}[f]$ we denote Fourier trigonometric series of f and its conjugate series respectively, i.e.

$$\sigma[f, x] = \frac{a_0}{2} + \sum_{k=1}^{\infty} a_k \cos kx + b_k \sin kx, \quad k = 0, 1, 2, \dots$$

$$\bar{\sigma}[f, x] = \sum_{k=1}^{\infty} -b_k \cos kx + a_k \sin kx, \quad k \in \mathbb{N},$$

where

$$a_k \equiv a_k(f) = \frac{1}{\pi} \int_T (t) \cos kt dt, \quad k \in \mathbb{N}, \quad b_k \equiv b_k(f) = \frac{1}{\pi} \int_T (t) \sin kt dt, \quad k \in \mathbb{N}.$$

$$\text{We imply, that } \bar{f}_n(x) = -\frac{1}{2\pi} \int_{\frac{\pi}{n}}^{\pi} [f(x+t) - f(x-t)] \cotg \frac{t}{2} dt, \quad n > 1.$$

If $f \in L^p(T)$, $p \in [1, +\infty]$ and $\delta > 0$, then the representation $\omega(\delta, f)_p = \sup_{|h| \leq \delta} \|f(\cdot + h) - f(\cdot)\|_p$, is called L^p -modulus of continuity of function f . If function $f \in L(T)$, and $\delta > 1$ is any number, then with $t_n^\alpha(x, f)$ symbol we denoted Cesaro means of $\bar{\sigma}[f]$ series, α order, or

$$t_n^\alpha(x, f) = -\frac{1}{\pi} \int_T f(x+t) \tau_n^\alpha(t) dt,$$

Theorem 1. Let $p \in (1, +\infty)$, $a \in (0, 1)$ and $ap \in]0, 1[$ then for the function $f \in C(T)$ the following inequality is true

$$\|\sigma_n^{-a}(f) - f\|_c \leq A(p, a) n^{\frac{1}{p}} \omega\left(\frac{1}{n}, f\right)_p + A(a)g(n, f).$$

Theorem 2. Let $a \in]0, 1[$ - is a number. If function $f \in C(T)$, $a, ap > 1$ then

$$\|t_n^{-a}(f) - \bar{f}_n\|_c \leq A(p, a) n^a \omega\left(\frac{1}{n}, f\right)_p + A(a)g(n, f).$$

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MODERN EDUCATIONAL TECHNOLOGIES FOR DECISION-MAKING IN LAW AND SOCIAL ACTIVITIES

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The present scientific paper outlines, that modern educational technologies as an integral part of scientific and technical progress, play the increasing role in a life and activity of a society. And educational technologies find the greatest application. They take a worthy place in all major spheres of a public life and the government. Certainly, the state in performance of such major function as maintenance of legality and the law and order, to aspire to use achievements of scientific and

technical development. And consequently to experts in the field of philosophy of jurisprudence, it is necessary to realize a place and a role of modern educational technologies in law-enforcement activity of bodies of the government. The present paper is devoted to this theme.

The paper emphasizes, that success of any kind of law-enforcement activity in many respects depends on a degree of its maintenance corresponding is long the saved up and systematized information on the crimes accomplished in the past, persons involved in them, means and ways of their fulfilment, various traces of crimes and the objects connected with criminal events, and also from an opportunity and skill of the inspector to use the similar information in the activity, for revealing, search and an identification of their interesting phenomena .

The paper discusses, that the legal practice is interested in the highly skilled staff delivered by education. And without development of the jurisprudence supported by practical check, such specialists to prepare it are impossible. As Georgian Philosopher Irma Bagrationi in her work "For the Issue of Contemporary Professional Requirements to the Specialist of Service of Marketing" points out, "Practice acts as the important criterion of quality check of preparation of specialists, checks the validity, value and an efficiency of scientific research on the basis of which formation is educated" [3].

The paper tells that a taken place introduction of programs of the automated technology of judicial office-work can be considered as the first stage in creation of effective system of judicial office-work in law-courts of the general jurisdiction. In a number of perspective technologies of information of courts technologies of recording of judicial sessions and uses of means of "video conferencing" are allocated. The technologies of a video conferencing intended for use by consideration of criminal cases in the cassation order, have passed experimental check. The decision of the problem connected with a wide circulation of technology of "video conferencing" [1]. The problem of telecommunication maintenance of information interaction of courts with bodies of the government, legal profession and law enforcement bodies of the Georgian demands the decision.

According to Georgian Philosopher Irma Bagrationi's work "Konstantine Kapaneli's Philosophical and Aesthetical Conceptions" "the professional-legal culture of the lawyer leans on legal culture of a society, "descend" from it. Simultaneously it influences it, lifts legal culture of a society up to higher level and serves as a stimulator of development. The maintenance of legal culture of the lawyer:

knowledge of rules of law, respect for the right, a habit to adhere to laws and service orders, conviction in correctness and validity of rules of law, an active vital position on duty” [2].

The concept provides creation of a uniform information infrastructure of courts with stage-by-stage expansion of the general center of information, inter-regional and the regional centers introductions of informational technologies. The centers specified above it is planned to create mainly on the basis of territorial managements of judicial department, having resources necessary for it and experience of information. In these centers groups of highly skilled experts for introduction of new computer technologies in activity of courts, and also support of operation and development of these technologies in a zone of the responsibility are created.

According to Georgian Philosopher Irma Bagrationi’s work “The Issue of Student Distance Communication and Collaboration(For Foreign Language Teaching)” information centers are head divisions in system of the educational & technological information: maintenance statistical, operatively-help, operatively-search, criminalistics and archival: “Education is a basis of cultural-legal, spiritual, social, economic development of a society and the state, "works" on a legal practice. Owing to the juridical education the intellectual, creative potential of people is enriched, its cultural level raises, there is a maintenance of management personnel, law-maker bodies, law-enforcement system the qualified specialists in the field of the right” [4].

The author concludes, that considering the general condition of information of courts of the general jurisdiction it is possible to draw following conclusions: the condition of the majority of courts existing now is characterized by a low level of their equipment means of information, absence of means of information interchange in the electronic form on liaison channels;development and introduction of means of information of courts restrain insufficient financing and absence of the necessary experts providing these processes and operation of educational technologies, developed for courts; equipment of courts by polytypic means of computer facilities complicates realization of their complex information.

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ON THE RENEWAL-REWARD PROCESS WITH REGULARLY VARYING COMPONENT

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In this study we consider a renewal-reward process ([1, 2])

$C(t) = \sum_{i=1}^{N(t)} X_i, \quad t \geq 0$, where $N(t) = \max\{n: S_n \leq t\}$ is a renewal process,

$S_n = \sum_{i=1}^n T_i, \quad \{(T_i, X_i)\}, \quad i \geq 1$ is a sequence of independent and identically

distributed random vectors with possibly dependent coordinates. We will denote the distribution of T by $F: F(t) = P\{T < t\}$.

Definition 1 ([3]). A function $L(t)$ is called slowly varying if $L(t)$ is defined for $t > 0$, positive, and if $\lim_{t \rightarrow \infty} L(xt) / L(t) = 1$ for all $x > 0$.

Definition 2 ([3]). A distribution function $F(t) \in V_\alpha$ for $\alpha \geq 0$ if there exists a slowly varying function $L(t)$ such that $1 - F(t) \sim t^{-\alpha} L(t)$ as $t \rightarrow \infty$.

The real number α is the exponent of $F(t)$, and $F(t)$ is said to be a regularly varying distribution with exponent α .

Theorem. If $F \in V_\alpha$ and $\lambda \equiv EX \neq 0$ exists, then as $t \rightarrow \infty$

$$D(t) \equiv E(C(t)) \sim \begin{cases} \frac{\lambda}{1-F(t)} & \text{if } \alpha = 0 \\ \frac{\lambda}{1-F(t)} \cdot \frac{\sin \alpha \pi}{\alpha \pi} & \text{if } 0 < \alpha < 1 \\ \frac{\lambda t}{\int_0^t (1-F(x)) dx} & \text{if } \alpha = 1. \end{cases}$$

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CREATIVE EXPRESSION IN MILITARY ORGANIZATIONS: A CASE OF LITHUANIAN ARMED FORCES

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Innovation and creativity in the workplace have become gradually more important elements of any organizational performance. The success in the military area in the peacetime or in the wartime is hardly possible without creativity on the part of the military organizations as a whole and the commanders and their staffs at all levels.

The military profession is characterized by the commitment of its members to unlimited service, extending to the risk of life itself. As in no other organization, the military trains its members to perform tasks they hope will never need to be performed. A military culture is defined as the sum of intellectual, professional, and traditional values possessed

by officer services. The military is a highly stratified organization, and its leaders require prompt and unquestioning obedience and execution of orders. Military institutions are often heavily bureaucratized. They force their members to apply numerous fixed techniques and procedures in the erroneous belief that this would enhance effectiveness.

Creativity is perhaps one of the most significant but least understood areas of human endeavour. The main obstacles to military creativity are posed by the military's authoritarian hierarchical command structure and its thinking, which is exemplified by conformity, groupthink, parochialism, dogmatism, intolerance, and anti-intellectualism.

The aim of this study was to investigate the relationship between individual, group and organizational creativity in the military organizations. The data for this research was collected by a questionnaire that was spread among 120 soldiers from Lithuanian Land Force. Structural equation model test was used to test the hypotheses and test a theoretical network of relationships among observed and latent variables that indicated creativity. This study was based on hierarchical structural model and for data analysis the SPSS AMOS 25 software was used.

ALGORITHMS OF WIRELESS NETWORK SECURITY

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Safety and service quality in wireless networks has recently become an important subject of active research, which is caused by the growing demand for supporting data packages. Without adequate security, organizations avoid using wireless networks. Security issues are an important obstacle for wireless network adaptation. Consequently, security of wireless networks is an important area, which requires reaction, if such networks are widely used. It is necessary for the researchers of this field to identify open problems and to provide relevant solutions to them. Each of such attempts makes the wireless network a bit more secure. The present work aims at the development of a number of measures that would contribute to increasing the safety of wireless networks and through which it would be possible to manage remote workstations.

Development of the main objectives of automated system begins with analysis of manual data processing in order to study and generalize

the difficulties that a user faces. Such a research is of a general nature and its aim is to identify the difficulties and not to determine their causes. Initially, there is a general examination of existing management procedures, and subsequently, the tasks of management, that are considered to be automated, are analyzed separately.

The algorithms are built for each method of security automated system and a separate algorithmic block is described by its functional purposes.

The algorithmic blocks also include a set of such programs that run various parts of the computer and allow a user to solve the task in a desired way.

In article corresponding algorithms and their computer programs are stated.

The research deals with the all above mentioned issues.

MAIN TASKS OF WIRELESS NETWORK SECURITY

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On the basis of the main tasks of the automated security system, it is necessary to define and develop system algorithms, information security and dialog procedures and create an automated system software complex.

The system requires the development of such dialogue procedures, which facilitate the organization of the relationship between a client and the system; it is selected in such a sequence, where such functions, as creating, updating, modifying, applying, reading, processing, exporting, etc. of data, are effectively implemented.

The efficiency of the solution of security supporting automated system depends on the system algorithmic support. For the optimal solution of this issue, a security task is allocated by separate algorithms for each method.

The algorithms are built for each method of security automated system and a separate algorithmic block is described by its functional purposes.

The initial stage of the algorithm's work is determined by the information, entered by a user. At the first stage a user's password is written in a special array, where the beginning and the end of a word are

defined. Also, the word is separated into symbols and an individual symbol has its own index.

Every network device has its own unique MAC address and, by checking its IP addresses, a biometrical authentication should be done to determine the identity of the devices before the information is transmitted.

The system algorithms and the informational support have been developed and determined on the basis of main tasks of the security supporting automated system. The input and output data has been set for each algorithm.

The research deals with the all above mentioned issues.

UNDERSTANDING BLEB FORMATION – A MACHINE LEARNING APPROACH

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Over the last couple of decades, cellular motility has been the subject of extensive research. The use of pseudopodia and flagella by cells as a means of propulsion is relatively well understood, however movement induced by bleb formation is somewhat lagging behind in this regard. One approach to modelling this phenomenon is adapting a deterministic cell geometric framework, where curvature turns out to be a significant factor. This model was fitted to actual data with positive outcomes; however it is well known that the biological world is far from being deterministic. Incorporating a stochastic element in modelling such a process might yield more realistic results, whilst offering a more flexible modelling paradigm. Tools and techniques in machine learning, such as the Hidden Markov Model (HMM), have successfully provided such frameworks in biology and various other fields. We aim to show how the HMM can be used to gain further insight into how blebs form. We start by introducing the HMM and give a cursory outline of its theory, before moving on to explaining how the HMM was implemented in our particular case and discussing the results obtained.

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ABOUT BANKRUPTCY OF INSURANCE COMPANY IN CASE OF LARGE PAYMENTS

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The problem of bankruptcy of insurance company in case of large payments was considered. As a result, asymptotical formulas of bankruptcy probability have been obtained [1], [2].

Also, we obtained a formula to define an admissible insurance rate in case of these payments [3], [4].

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ABOUT GENERAL SYSTEMIC PRINCIPLES IN DSS

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In [1] we consider an ontology of DSS, an important component of which is the manifestation of the system of DSS through 8 system-wide principles.

The following interpretations of the principles are proposed:

- 1) **The anthropic** principle – the entities are DM and experts, developers only improve the designer of the solutions.
- 2) The principle of **the optimal plan** – among the components of the DSS is only the DM, experts, solutions and the constructor/interpreter of the solutions.
- 3) The principle of **redundancy** – the basis of decisions and experts, which update the decision; solutions can be exchanged.
- 4) The principle of **economy** – the DSS incapsulates everything that is needed for DM. DSS is a wrap of the decision.
- 5) The principle of **completeness of time** (everything happens at the optimal time) – DSS tends to implement the DM plan “here and now”.
- 6) The principle of **preservation** (confrontation with external negative influences) – components of technological excellence [2].
- 7) The principle that all works on the system – the presence of logic, interaction and solutions patterns.
- 8) The principle of **the employment of the mechanism** – the search and exchange of solutions (logical and interaction patterns) as components of the life cycle of the DSS.

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SEQUENTIAL TEST FOR EXPONENTIAL MODEL

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Let $\xi_1, \xi_2, \dots$ be a sequence of i.i.d random variables having distributions with density $f(x, \theta)$, where $\theta \in \{\theta_0, \theta_1\}$. Wald's sequential probability ratio test (SPRT) for hypothesis $H_0: \theta = \theta_0$ versus alternative $H_1: \theta = \theta_1$ has the following form. Set $S_n = \sum_{i=1}^n \frac{f_1(\xi_i, \theta_0)}{f_0(\xi_i, \theta_1)}$, $S_0 = 0$ and let α, β be the errors of the first and the second kind respectively. Let

$$\tau = \min\{n: S_n \notin (-a, b)\}.$$

If $S_\tau \leq -a$ we expect the hypothesis H_0 and we reject H_0 and except H_1 if $S_\tau \geq b$. The numbers a, b are defined by the errors of the first and the second and their approximate values are

$$a = -\ln \frac{\beta}{1-\alpha}, b = \ln \frac{1-\beta}{\alpha}.$$

The problem of finding the exact values for a, b for given errors of the first and the second kind is connected with exact distribution of the stopping time τ . For exponential model (i.e. if ξ_i have exponential distribution) this problem was discussed in [1, 2].

In the report we propose some new approach which enables us to find the exact values of a, b for given α, β .

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GENERATOR OF STOCHASTIC VOLATILITY WITH SEMI-MARKOV SWITCHING

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In this paper consider the dynamical system of financial market model with regard to the stochastic volatility. The first equation of this system has a representation[1]

$$ds / s = -\mu(t, x)dt + \sigma(t, x)dw_t, \quad (1)$$

where asset rate s , functions μ (share price with taking into account dividend payments) and σ (historical volatility with taking into account not normal distribution) depend on two components, namely, time t and semi–Markov process x [2]; w_t – standard Wiener process.

Under consideration of the ten–year’ time interval, we can see jumps of volatility, after which failures in the working strategy are followed. These are triggers to change the property market. Thus, it is necessary to optimize the parameter of the equation (1). Then, the size of the flat diapason, circle period and format of the trend will being changing.

Second equation for the stochastic volatility is given in the form

$$d\sigma = a(\sigma, x)dt + b(\sigma, x)dw_t, \quad (2)$$

where $x(t)$ – uniformly ergodic semi–Markov process with generating operator Q in standard phase space of states (X, Θ) with stationary distribution $\pi(B), B \in \Theta$. Solution of equation (2) converges to the solution of corresponding averaged equation over the second component x . Conditions of convergence in the terms of existence of Lyapunov function were received.

Generator for equation (2) of stochastic volatility σ is as follows

$$C(t)\varphi(\sigma) = C(\sigma, x)\varphi'(\sigma) + 1/2B^2(\sigma, x)\varphi''(\sigma), \varphi \in B(X).$$

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STOCHASTIC APPROXIMATION PROCEDURE FOR DIFFUSION PROCESS WITH SEMI-MARKOV SWITCHING

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Stochastic approximation procedure (SAP) with allowance for external influences on the regression function $C(u, x)$ is described by the equation

$$du^\varepsilon(t) = a(t)[C(u^\varepsilon(t), x(t/\varepsilon))dt + \sigma(u^\varepsilon(t), x(t/\varepsilon))dw.$$

where $x(t), t \geq 0$, semi-Markov uniformly ergodic process in the phase space $(X, \mathbf{X})$ [1].

In the report we develop the conditions of the convergence of the SAP with the small parameter $\varepsilon > 0$ which leads to the establishment of the asymptotic properties of the random evolution of $u^\varepsilon(t)$.

Using the scheme of diffusion approximation and asymptotically small diffusion we obtained convergence SAP. The same method is used for continuous stochastic optimization procedure. And using small parameter we have got asymptotic dissipative [2] for such procedures in the Poisson approximation scheme [3].

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THE SCORING OR RANKING MODEL FOR ASSESSING THE QUALITY OF EDUCATION

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Nowadays, one of the main concerns of Georgian education is to improve the education quality monitoring and management. The studies are actively undertaken in order to process the national system of education quality assessment through the realization of current study programs. Nevertheless, there is not yet a single conceptual and methodical ideology for solving this problem. There are often unacceptable and non-standard approaches. There is no scientific and methodological maintenance and normative-legal basis for education quality assessment.

Solving these problems needs a deliberate effort to determine the systemic approach to education quality assessment at all levels and stages of education.

The presented report provides a review of one model of education quality assessment as a system that includes the scientific methodological maintenance for quality assessment.

The simplest formalized model of education quality assessment is a degree and ranking model. During the degree model of assessment, the points are given to the selected objects. This is the simplest method of ranking. In this way, there is the possibility to sort out the assessment objects by ranks.

Let's take the following symbols:

$U_i, i = \overline{1, n}$ - the selected n object of any attribute quantity indicators at t time control moment. In our case, the object is a higher educational institution, its quantitative feature importance is taken from the range of assessments:

$Q = \{good, bad, average, etc.\};$

$W_i, i = \overline{1, n}$ - the weight coefficient set by experts with the the Euristic method;

$R_i, i = \overline{1, n}$ - the general rating of the selected control element that is calculated with the following formula:

$$R_i = \sum_{i=1}^n U_i W_i.$$

The suggested model of the ranking assessment has the advantages and disadvantages as well. The advantage is the simplicity of its building and accuracy of calculation, while the negative side is that the weight coefficients are determined by experts. The reliability of weight coefficients obtained through expert way depends on the methodology and means used in the assessment process. This creates some difficulties since in some cases the method cannot be adequately selected. Another disadvantage is that it is difficult to consider the interdependence of U_i quantitative indicators. The latter is defined in processing of statistical data. Nevertheless, the suggested model may have much more use than more accurate, but more complex models. Our practical experiment demonstrated that where the difficult models are not reasonable to use, the ranking model is more efficient and gives the optimum results.

THE PROPERTIES OF THE STATIONARY BEHAVIOR OF THE PARALLEL NETWORK

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We consider a model which consists of two parts. One part of the model is an open multichannel network type and second part is a separate multichannel system. The parts of our model have the r common Poisson input flows of customers $(\nu_1^i(t), \nu_2^i(t))$, $i=1, r$ with parameters b_i . One of the customers arrives to the part operating as a network with nodes $E_1, \dots, E_r$. Another customer goes for a service to the separate queueing system E_0 . After completing server in only one part they depart the model. The service times at the node E_i ($i=0, r$) have the exponential distribution with parameter $\mu_i > 0$. Suppose that $X_i(t)$, ($i=0, r$) is the number of customers in the nodes, $\Phi(z, t)$ is the generation function of the vector $X(t) = (X_0(t), \dots, X_r(t))$.

Theorem The stochastic process $X(t)$ has the limit distribution of the following type

$$\lim_{t \rightarrow +\infty} \Phi(z, t) = \exp \left\{ - \left(\mu_0^{-1} \sum_{i=1}^r b_i - \left(bP^*(\mu_0), \vec{1} \right) \right) (1 - z_0) - \right. \\ \left. - \left(\alpha D^{-1}(\mu) - bP^*(\mu_0), \vec{1} - z \right) - \left(bP^*(\mu_0), \vec{1} - z_0 z \right) \right\},$$

where $D(\mu) = \left\| \mu_i \delta_{ij} \right\|_{i,j=1}^r$, $P^*(\mu_0) (I - Q^*(\mu_0))^{-1} D(g(\mu))$,

$$Q^*(\mu_0) = \left\| -p_{ij}(\mu_0 - \mu) \right\|_{i,j=1}^r$$

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PREDICTING AND DECISION-MAKING IN MEDICINE

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The mentioned issue is particularly important because it is directly related to the correct and timely prediction in the medicine, which is itself a priority, as it allows the individualization of the medical intervention. No matter how well we master the "Golden Standard" of the objective medicine, the doctor should have the ability to adopt these standards individually and make a modernization of them to the condition of a particular patient. In order to make his/her decision based on knowledge and firmed by practical experience.

I, as the representative of one of the important fields of medicine - Stomatology - would like to mention that only knowledge and doctor's erudition are not sufficient for faithful implementation of the issue under discussion (correct predictions, diagnostics and decision-making). The convenient and appropriate technical equipment provided by the principles of ergonomics, and proper technical equipment for work are also required. Dental treatment of the patient cannot always be done under the mentioned principles that lead to the probability of mistakes and complications. The present process is dynamic. The evolution of

medical science and technical methodology implies the implementation of renewed scientific knowledge, which keeps the constant relevance. The fact that the process of treatment of the patient in the Stomatology does not always follow the ergonomic principles - in the process of work the work equipment and the environment mainly do not meet the ergonomic requirements, the strongest overloading of the Stomatology appears, which significantly damages the patient's health and causes the development of various pathologies. Therefore, the problem is the establishment of the exact schema of the principles of ergonomics in the process of the dentist's work, taking into account the modern requirement and their introduction to practice for the purposes of implementation of the timely preventive measures. The logic chain is that, in my opinion, the doctor which is equipped with appropriate skills, knowledge, and so on, if not being in a safe environment for his/her health and experiencing physical or mental discomfort him/herself, he/she loses the capability, his/her enthusiasm decreases and he/she even switches from the doctor's to the patient's role. The requirements of the doctor are always emphasized, for instance, that he/she must timely and promptly fulfill the collection of anamnesis, make a diagnosis, make the prediction of the possible complications, make an appropriate decision, however we should not forget that for the successful implementation of all the above mentioned the doctor him/herself should work in the environment safe for his/her health. As for the doctor's relevant education, it is known that people better remember the issues that they thoroughly understand, the basis for which is created by clinical anatomy which, for the interests of the medical treatment, represents the deep study of morphological foundation of the disease and implies consideration of the age-rated changes of human body, organs and systems and their variations, within the frames of the competency of this clinical disciplines the sphere of which is represented by correct and timely treatment of the manifestation of the pathology appeared before the doctor. For example, the secretion of blood and pus from alveolar of removed upper tooth together with air bubbles which may get out with the whistle from alveolus of removed upper tooth. It should be noted that when examining the patient, the surgical spoon is deeply absorbed in tooth alveola without any obstruction. If the doctor knows the morphological basis of the mentioned clinical issue, he/she will surely come to the relevant correct decision which would be the stitching up of the mucous membrane of removed tooth, the following fact makes the basic

foundation for the abovementioned: every dentist is aware that the lower wall of the upper jaw entrails (entrails of the Highmore) is bordered to the upper tooth socket alveola and corresponds to the second - small and the 1st and 2nd big major teeth roots. In case of pneumatic structure of upper jaw entrails the small and big main teeth roots are separated from the entrails bottom with the thin bony sheet the thickness of which may vary between 2-0.3 mm and which in some cases may not exist at all or during removal of tooth it may break and the antrum of Highmore may open as a result of which in case of accompanying of purulent process it causes the above-mentioned processes, which requires stitching up the mucous membrane. Thus, in this case, the doctor's ability to correctly manage and use the knowledge in the certain individual situation took a significant role in making of a correct decision and prediction.

The correct use of knowledge and information in a very clear and detailed way is described in Bloom's Taxonomy, which teaches us that if the knowledge is not followed by the correct analysis and the ability to use it in practice, it remains in our memory as the useless, chaotic information.

For doctor to manage the prediction of future results and make a correct decision he/she shall be able to assess the actual situation objectively, to sort the necessary knowledge existing in his/her consciousness and make a correct conclusion as a result of such information appeared in an individual case.

EXPOSURE RISK POSED BY INORGANIC CONTAMINANTS IN DRINKING WATER

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This presentation builds on the presentation given by Armand Maul at (EnviroInfo 2017). Maul illustrated the principles largely using simulated data. Rather than risk from concentrations of pathogens as discussed in his presentation, we apply the concepts to inorganic toxicants.

Maul (2017) showed the importance of heterogeneity in assessing the influence of microbial behavior in the estimation of risk of disease. The four items that need to be considered in estimating risk from harmful exposure (with slight adaption) are:

- (1) the dose-response relationship,
- (2) the frequency of exposure,
- (3) the mean concentration of the toxicant, and
- (4) the degree of heterogeneity of the distribution of the toxicant.

In this presentation we apply the principles to a large data set of analyses of inorganic toxicants from several thousand wells in Punjab state, India. The data were collected by World Bank in 3 phases and included information on 14 analytes. In this presentation we consider 4 contrasting situations with arsenic, chromium and fluoride and uranium.

The analyses were performed at various laboratories, each with their own limit of reporting. That complicates the challenge of values below reporting level. Not all analytes were assessed on all samples – there were therefore missing values. Many wells were sampled in more than one phase of the study – the problem of multiple readings from the same well was avoided by using only data from Phase 1 of the collection.

We model dose response using a step function based on water quality guidelines. Frequency of exposure we approximate to that used for establishing the water quality guidelines. The mean and heterogeneity were obtained directly from the observed distribution of the analytes. Following Maul, we also use gamma distributions to model the statistical distributions of the concentrations of the analytes.

The concepts of Maul (2017) were then used to contrast estimates of risk using a simple mean and those obtained by taking into account the heterogeneity of the data. We then consider the effect of kriging the data on the estimation of risk from toxicity. Use of the sample mean to predict the risk gave an incomplete assessment of the risk compared with an assessment based on the observed distribution. Modelling the concentrations using a gamma function resulted in decreased predicted risk. A similar effect was noted with Kriged data because of its smoothing effect. This was particularly the case with chromium where some wells posed a very high risk but there was no risk when the assessment was from the modelled data. It is concluded that too much modelling of the data can mask local areas of high risk.

Some analytes are important for human health. In the current examples, fluoride is necessary for dental health – fluoride is added to many water supplies for that reason. The concepts of Maul could be slightly modified to look at the dose-response of very low concentrations where the measure is benefit rather than harm. This may be an open research topic.

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ON SOME PROBLEMS OF INFORMATION OVERLOAD FOR DECISION MAKING PROCESS

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The present paper outlines that Information overload is "a gap between the volume of information and the tools we have to assimilate" it. Information used in decision making is to reduce or eliminate uncertainty. Excessive information affects problem processing and tasking, which affects decision-making. An American Scientist and Programmer Crystal Hall described an "illusion of knowledge", which means that as individuals encounter too much knowledge it can interfere with their ability to make rational decisions [2].

The paper underlines, that decision-making techniques can be separated into two broad categories: group decision-making techniques and individual decision-making techniques. Individual decision-making techniques can also often be applied by a group. In groups, people generate decisions through active and complex processes. One method consists of three steps: initial preferences are expressed by members; the members of the group then gather and share information concerning those preferences; finally, the members combine their views and make a single choice about how to face the problem. Although these steps are relatively ordinary, judgments are often distorted by cognitive and motivational biases, include "sins of commission", "sins of omission", and "sins of imprecision" [4].

The paper is interested in some questions: problems are merely deviations from performance standards, problems must be precisely identified and described, problems are caused by a change from a distinctive feature, something can always be used to distinguish between

what has and hasn't been affected by a cause, causes of problems can be deduced from relevant changes found in analysing the problem, most likely cause of a problem is the one that exactly explains all the facts, while having the fewest assumptions [5].

The papertells, that According to An American author and co-creator of personality inventory known as the Myers-Briggs Type Indicator, Isabel Briggs Myers a person's decision-making process depends to a significant degree on their cognitive style. In her analysis on styles and methods. She referred to the game of chess, saying that "chess does disclose various methods of operation, notably the creation of predisposition-methods which may be applicable to other, more complex systems. Isabel Briggs Myers states that apart from the methods (reactive and selective) and sub-methods (randomization and programming), there are two major styles: positional and combinational. Both styles are utilized in the game of chess. According to Isabel Briggs Myers, the two styles reflect two basic approaches to uncertainty: deterministic (combinational style) and in-deterministic (positional style). Isabel Briggs Myers's definition of the two styles are the following. The combinational style is characterized by: a very narrow, clearly defined, primarily material goal; and a program that links the initial position with the final outcome. In defining the combinational style in chess, Isabel Briggs Myers wrote: "The combinational style features a clearly formulated limited objective, namely the capture of material (the main constituent element of a chess position). The objective is implemented via a well-defined, and in some cases, unique sequence of moves aimed at reaching the set goal. As a rule, this sequence leaves no options for the opponent. Finding a combinational objective allows the player to focus all his energies on efficient execution, that is, the player's analysis may be limited to the pieces directly partaking in the combination. This approach is the crux of the combination and the combinational style of play" [1].

Decision-making can be regarded as a problem-solving activity terminated by a solution deemed to be optimal, or at least satisfactory. It is therefore a process which can be more or less rational or irrational and can be based on explicit or tacit knowledge and beliefs. Human performance has been the subject of active research from several perspectives: Psychological: examining individual decisions in the context of a set of needs, preferences and values the individual has or seeks; Cognitive: the decision-making process regarded as a continuous process integrated in the interaction with the environment; Normative:

the analysis of individual decisions concerned with the logic of decision-making and the invariant choice it leads to [3]. A major part of decision-making involves the analysis of a finite set of alternatives described in terms of evaluative criteria. Then the task might be to rank these alternatives in terms of how attractive they are to the decision-maker when all the criteria are considered simultaneously. Another task might be to find the best alternative or to determine the relative total priority of each alternative (for instance, if alternatives represent projects competing for funds) when all the criteria are considered simultaneously. Solving such problems is the focus of multiple-criteria decision analysis. This area of decision-making, although very old, has attracted the interest of many researchers and practitioners and is still highly debated as there are many multiple-criteria decision analysis methods which may yield very different results when they are applied on exactly the same data. This leads to the formulation of a decision-making paradox. Logical decision-making is an important part of all science-based professions, where specialists apply their knowledge in a given area to make informed decisions. For example, medical decision-making often involves a diagnosis and the selection of appropriate treatment. But naturalistic decision-making research shows that in situations with higher time pressure, higher stakes, or increased ambiguities, experts may use intuitive decision-making rather than structured approaches. They may follow a recognition primed decision that fits their experience and arrive at a course of action without weighing alternatives. The decision-maker's environment can play a part in the decision-making process. For example, environmental complexity is a factor that influences cognitive function. A complex environment is an environment with a large number of different possible states which come and go over time [4].

The author concludes, that it is important to differentiate between problem analysis and decision-making. Traditionally, it is argued that problem of Information overload and analysis must be done first, so that the information gathered in that process may be used towards decision-making.

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STUDENT LOAD CREDIT SYSTEM

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An educational credit measures a student's work capacity, which is necessary to acquire certain competencies, i.e. to master the material, to perform any kind of assignment. The introduction of ECTS means that educational programs and the entire educational processes should be oriented on a student, because they are based on a student's academic load. A correct calculation of a student's academic loading requires the correctly set goals, the possible results expected after the program completion. The objectives of the educational program are desirable to be determined by outcomes and competences of the study. These comparatively new terms denote the following well-known features: the study outcomes show what a student needs to know, understand or do after the completion of a short or long term educational process, i.e. what general or specific competence acquisition is promoted by this or that program.

In this context, first of all, it is necessary to bring all the actually effective educational programs into line with a few basic types and a level of education.

The research deals with the all above mentioned issues.

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ON SOME PROBLEMS OF INFORMATION OVERLOAD FOR DECISION MAKING PROCESS

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The paper underlines, those decision-making techniques can be separated into two broad categories: group decision-making techniques and individual decision-making techniques. Individual decision-making techniques can also often be applied by a group. In groups, people generate decisions through active and complex processes. One method consists of three steps: initial preferences are expressed by members; the members of the group then gather and share information concerning those preferences; finally, the members combine their views and make a single choice about how to face the problem. Although these steps are relatively ordinary, judgments are often distorted by cognitive and motivational biases include "sins of commission", "sins of omission", and "sins of imprecision".

The paper is interested in some questions: problems are merely deviations from performance standards, problems must be precisely identified and described, problems are caused by a change from a distinctive feature, something can always be used to distinguish between what has and hasn't been affected by a cause, causes of problems can be deduced from relevant changes found in analysing the problem, most likely cause of a problem is the one that exactly explains all the facts, while having the fewest assumptions [5].

Decision-making can be regarded as a problem-solving activity terminated by a solution deemed to be optimal, or at least satisfactory. It is therefore a process which can be more or less rational or irrational and can be based on explicit or tacit knowledge and beliefs.

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TASK OF MODELING THE SINGLE-LINE NEURAL NETWORKS

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Let's consider a neuron network that consists of n neurons. The condition of i -th neuron is characterized by the function $x_i(t)$, $i = \overline{1, n}$, the dynamics of is described by the following system of differential equations:

$$x'_i(t) = h_i(x(t)) + \sum_{j=1}^n [w_{ij}^0 + w_{ij}(t)] g_j(x(t)), \quad i = \overline{1, n} \quad (1)$$

Here $h_i(x)$, $g_i(x)$ are constantly differentiated functions on the given R^n , $x(t)$ is a continuous function, w_{ij}^0 and $w_{ij}(t)$ are the weighting coefficients that characterize the i -th neuron impact on the j -th neuron, at the initial conditions of $x_i(0) = a_i$, $i = \overline{1, n}$.

The system of differential equations (1) can be represented in the following vector form:

$$x'_i(t) = h(x(t)) + (W_0 + W(t))g(x(t)) \quad (2)$$

With the following initial conditions:

$$x(0) = a \quad (3)$$

here $a = (a_1, a_2, \dots, a_n)$; W_0 is a constant $n \times n$ matrix which consists of w_{ij}^0 elements; a dimensional matrix $n \times n$, consisting of the weighting coefficients $W(t)$ - $w_{ij}(t)$, is considered as the management functions and can be distributed to $|w_{ij}(t)| \leq A_{ij}$, $i, j = \overline{1, n}$ limitations.

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FORECASTING TASKS FOR THE SPECIALISTS' DEMAND

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The task of predicting the specialists' demands is hardly the formalized class of tasks and this feature should be taken into consideration in the process of modeling.

The prediction represents a specific prophecy, based on scientific justification, about the future situation of any event in future behavior of the object. Forecast classification takes time: short, medium, long-term, and functional: research, software and resource characteristics.

For forecasting, i.e. obtaining future information, it is necessary to study the normality, parameters of the processes on the object and determine the driving force of its development, which is the main task of planning and forecasting.

The high rate of qualified specialists in the labor market is due to the dynamic development of the country's economic processes, with the structural and qualitative changes of the labor market, highly qualified labor requirements, which led to the expulsion of a qualified specialist from the labor market. In this regard, the interest was strengthened to improve personnel policies that helped to solve the problems of creation of specialists' demand-delivery forecasting system.

In case of a specific prediction and for the choice of its solution method, it is necessary thoroughly and accurately describes its terms, assumptions, and limitations in the framework of which we are going to make predictions.

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IMPORTANCE AND PROBLEMS OF MARINE TRANSPORTATION

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It should be noted that one of the main indicators of the road is maximal usage of its bandwidth/capacity. The latter, along with other indicators, will be reflected in the concept of optimizing the production of transport loading-unloading operation.

The main research topic is transportation by maritime transport means. Transportation during maritime transportation may encounter a lot of problems in order to optimize the production of loading-unloading operations on the vessel, minimizing operating costs and avoiding harmful impacts on the environment. In order to solve these issues it's necessary to implement united, centralized management of transport and logical thought-making decisions related to logistical operations.

All above mentioned could be accomplished only with the development of transport infrastructure equipped with modern technologies and technical characteristics equal to world standards. Obviously, the main component of this infrastructure is marine ports and terminals equipped with modern technologies, including rail and road infrastructure schemes and are considered in the environment of common issues.

Despite the fact that the tasks planning transport infrastructure is not new and the work is being fulfilled worldwide, the problems related to it are not fully studied and processed. This is related to many objective factors, from which we can define an untold absence of modern information technologies and computer techniques.

These surveys should identify the intensification of growth of transit cargoes and focus on accelerating the socio-economic development of the country without causing harm and creating new problems in other directions (e.g. ecological, demographic, and other issues).

The research deals with the all above mentioned issues.

GENERATING SETS OF THE COMPLETE SEMIGROUPS OF BINARI RELATIONS DEFINED BY SEMILATTICES OF THE PENTAGON

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Let X be an arbitrary nonempty set, D is an X – semilattice of unions which is closed with respect to the set-theoretic union of elements from D , f be an arbitrary mapping of the set X in the set D . To each mapping f we put into correspondence a binary relation α_f on the set X that satisfies the condition $\alpha_f = \bigcup_{x \in X} (\{x\} \times f(x))$. The set of all such α_f ($f: X \rightarrow D$) is denoted by $B_X(D)$. It is easy to prove that $B_X(D)$ is a semigroup with respect to the operation of multiplication of binary relations, which is called a complete semigroup of binary relations defined by an X – semilattice of unions D .

Let $\Sigma_2(X, 5)$ be a class of all X – semilattices of unions whose every element is isomorphic to an X – semilattice of unions $D = \{Z_1, Z_2, Z_3, Z_4, Z_5 = \bar{D}\}$, which satisfies the conditions:

$$\begin{aligned} Z_4 \subset Z_3 \subset Z_1 \subset Z_5 = \bar{D}, \quad Z_4 \subset Z_2 \subset Z_5 = \bar{D}, \quad Z_3 \setminus Z_2 \neq \emptyset, \\ Z_2 \setminus Z_3 \neq \emptyset, \quad Z_1 \setminus Z_2 \neq \emptyset, \quad Z_2 \setminus Z_1 \neq \emptyset. \end{aligned}$$

Let $\Sigma_{2,1}(X, 5) = \{D \mid D \in \Sigma_2(X, 5) \text{ and } Z_4 = \emptyset\}$.

Theorem 1. Let $D \in \Sigma_{2,1}(X, 5)$, $X \setminus D \neq \emptyset$ and

$\mathfrak{A}_0 = \left\{ \{Z_4, Z_3, Z_2, Z_1, \bar{D}\}, \{Z_3, Z_2, Z_1, \bar{D}\} \right\}$, $B_0 = B(\mathfrak{A}_0) = \left\{ \alpha \in B_X(D) \mid V(X^*, \alpha) \in \mathfrak{A}_0 \right\}$, (see [1]), then B_0 is irreducible generating set for the semigroup $B_X(D)$.

Theorem 2. Let $D \in \Sigma_{2,1}(X, 5)$, $X \setminus D \neq \emptyset$ and

$$\mathfrak{A}_0 = \left\{ \{Z_4, Z_3, Z_2, Z_1, \bar{D}\}, \{Z_3, Z_2, Z_1, \bar{D}\} \right\}, B_0 = B(\mathfrak{A}_0) = \left\{ \alpha \in B_X(D) \mid V(X^*, \alpha) \in \mathfrak{A}_0 \right\},$$

then the number of elements of the set B_0 is equal to $|B_0| = 5^n - 3 \cdot 4^n + 3 \cdot 3^n - 2^n$.

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SYSTEM OPTIMIZATION PROBLEMS WITH OBJECTIVES BASED ON THE SIXTH KONDRATIEV CYCLE PREDICTIONS

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One of the instant issues for increasing of the economic potential of Ukraine is the determination of strategically important innovative industry sectors and the directions of their development. The Kondratiev cycle analysis [1] is used in this work in order to determine these sectors. There are six Kondratiev cycles (waves), each one of which is associated with the emergence of certain scientific or industrial inventions or the emergence and rapid development of innovative industries. The first wave is the production of fabrics and metal smelting. The second wave is the invention of steam engine, railways and steel production. The third wave - electricity and internal combustion engines. The fourth wave - petrochemicals, electronics and aircraft. The fifth wave - digital networks and information technologies.

According to the predictions, the sixth wave of the Kondratiev cycles (henceforth 2025 to 2060) will be characterized by such innovative industries as: nuclear electric energy, biotechnologies, nanotechnologies, waste recycling and alternative energy sources. Two of these sectors are relatively developed in Ukraine - nuclear energy and waste recycling. For this reason, the above sectors were chosen as subject for the research. The system optimization technology [2] was applied as a methodology for decision of change management problems. In order to analyze the further directions of the development of the mentioned sectors, system optimization objectives were formalized and resolved. Target points of system optimization objectives were chosen according to the predictions for the sixth Kondratiev cycle. Restrictions and criteria for system optimization objectives are subject to 2016 and 2017 annual reports and 2018 quarterly report of the Ministry of Science of Ukraine.

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DYNAMIC FEATURES OF UKRAINIAN HRYVNYA EXCHANGE RATE VARIATION

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The paper deals with the research of statistical and dynamical features of exchange rate variation of Ukrainian currency (UAH) to American dollar(USD) within 21 years (from 1996 to the end of 2017). Statistical characteristics of the daily exchange rate data sets were calculated. In order to fit exchange rate data sets was used the probability distribution fitting procedure. Also, the statistical goodness of fit methods was used to assess the quality of fitting for identifying the best candidate distribution. Dynamical features of exchange rate variation have been assessed using modern methods of time series analysis[1].

To quantify long range correlation properties of the exchange rate variation DFA (Detrended Fluctuation Analysis) method was used[2]. After documentation of scale depending memory features of UAH/USD, in order to have further arguments on time depending changes in dynamics of exchange rate variation, RQA (Recurrence Quantification Analysis) method was applied as well recognized mean to detect and quantify recurring patterns [3].

Finally, it was shown that long-range correlations and dynamic features of UAH/USD exchange rate variation reveal clear time scale dependence. These changes were explained as related to the internal changes and also strong external influences, which affected Ukraine economy in the afore time period. Precisely, increased long-range correlation in the variation of exchange rate was found in time periods when Ukrainian economy was impacted by the internal and international crises[1-3].

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MARKETING OBJECT MODEL WITH CULULATIVE EFFECT

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Importance of the problem is conditioned by the wish of the companies to have clear answer to the question of how marketing influences the profitability namely what is marketing elasticity. Analysis of the previous periods helps defining coefficient of impact of marketing to the profit in current time period. Indicated information is instrument of analysis of effect of marketing solutions, defining period of influence of marketing campaigns and forming the budget.

As an economic model we consider the system of simultaneous equations dependency of the profit, marketing costs, accumulated marketing expenses, sales volume, cost of goods sold and gross domestic product per capita:

$$\begin{cases} u_t = f_1(a_t, A_t, q_t, c_t, y_t) \\ a_t = f_2(u_t, A_t) \end{cases}$$

where u_t – profit, a_t – marketing costs at a current period, A_t – accumulated marketing; q_t – sales volume, c_t – costs of goods sold.

Where u_t, a_t – endogenous variables, a_t, A_t, q_t, c_t, y_t exogenous variables. Indicated model is unidentified. [2]

For creation of the model of marketing volume with cumulative effect exponential dependance of sales volume from marketing in chosen [3].

$$u_t = \beta_0 a_t^{\beta_1} A_t^{\beta_2} q_t^{\beta_3} c_t^{\beta_4} y_t^{\beta_5}; \quad a_t = \gamma_0 u_t^{\gamma_1} A_t^{\gamma_2};$$

where β_0, γ_0 – constant, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \gamma_1, \gamma_2$ – corresponding elasticity.

Analysing profit logarithm from the sales volume econometric mode will have the following equation:

$$\begin{cases} \ln u_t = \beta_0 + \beta_1 \ln a_t + \beta_2 \ln A_t + \beta_3 \ln q_t + \beta_4 \ln c_t + \beta_5 \ln y_t + \varepsilon_{1t} \\ \ln a_t = \gamma_0 + \gamma_1 \ln u_t + \gamma_2 \ln A_t + \varepsilon_{2t} \end{cases}$$

For evaluating the system of simultaneous structural equations in which undervalued and overvalued equations are present two step least squares method is used.

The verification of the statistical significance of all model ratios can be done using the t-statistics of Student's and Fisher's.

Consequently, the coefficient of elasticity of advertising on demand can be considered a coefficient γ_1 .

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MATHEMATICAL MODEL OF PUMPING OF DEEP CENTERS BY THE ENERGY OF LONGITUDINAL ACOUSTIC OSCILLATIONS AND ITS COMPUTER SOFTWARE

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The interaction of a hot electron with an electric dipole moment creates a torque that has a force that is inversely proportional to the scattering time. Because of the short-range action of quantum forces, the force at the center of mass of the perturbed DC is large and contributes to a decrease in symmetry [3].

If a part of levels is shifted downwards, the strong excitation of such a DC affords it the properties of an acceptor of the upper half of the forbidden zone. The shift of such energy levels to the center of the forbidden zone means an increase in the activation energy, which explains the observed increase in the threshold current of N-shaped

formation. At an electron energy of 0.676 eV, it is clearly seen that the N-shaped portion 2-3 consists of (7) discrete small N-shaped portions of the VAC with its hysteresis loops. Such a complex structure can be explained by the capture of D valley electrons by the excited center due to the splitting and displacement of a number of levels in a strong field. Initially, the center is in a stable state $[Fe^{3+}O^{3-}]$, since Fe^{3+} is more stable than Fe^{2+} in the state: $[Fe^{2+}O^{2-}]$ ($3d^6 4s^0 2p^6$). At position 3 and higher, the dispersion effect of this DC is saturated and exhausted. Further, the electrons are scattered mainly on the ionized impurity and the DC becomes charged due to the removal of degeneracy. Under these conditions, the conductivity increases due to increased mobility.

The conclusion. It is shown that at 77K the deep centers change their properties due to the magnitude of the external electric field intensity by localizing the energy and becoming the centers of dispersed scattering and electron capture with decreasing symmetry.

A computer program has been compiled for their calculation.

MINIMAX PROBLEMS FOR RANDOM FIELDS FROM OBSERVATIONS IN AREAS WITH PECULIARITIES

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Estimating of the unknown values of a random field in an area that represents a system of embedded rectangles is of interest in the study of random fields with singularities. Interpolation problems were investigated for the random stationary sequences by A.M. Kolmogorov [1], N. Wiener, A.M. Yaglom, M.I. Yadrenko. Estimators of the functionals of random fields were created by M.P. Moklyachuk and N.Y. Shchetsyuk [2]. Traditional methods of solution of these problems are employed under the condition that spectral densities are known exactly. In practice, however, complete information on spectral densities is impossible in most cases. To solve the problem the parametric or nonparametric estimates of the unknown spectral densities are found or these densities are selected by other reasoning. Then the traditional estimation method is applied provided that the estimated or selected densities are the true one. This procedure can result in a significant

increasing of the value of the error as K. S. Vastola and H. V. Poor have demonstrated with the help of some examples. These estimates are called minimax since they minimize the maximal value of the error.

The problem of estimations of linear functionals which depend on the unknown values of homogeneous random field $\xi(k, j)$ can be observed in the area with peculiarities $K \subset Z^2$ from observations of the sum $\xi(k, j) + \eta(k, j)$ at points $(k, j) \in Z^2 \setminus K$ is investigated. Formulas for calculating the mean square errors and the spectral characteristics of the optimal linear estimate of functionals from observations in the area with peculiarities are derived in the case where the spectral densities are exactly known. Formulas that determine the least favorable spectral densities and the minimax(robust) spectral characteristics are proposed where the spectral densities are not exactly known while a class of admissible spectral densities is given.

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PROBLEMATIC-SITUATIONAL EXPERIENCE

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The project as a method corresponds to the context of the humane perspective. In this project the communication and the collaboration have a considerable role. Least important the role of one-sided presenting of knowledge. Studying proceed in common, knowledge and experience of every student are very valuable. The meaning of in common studying is founded on the social character of the learning process.

The knowledge, value and attitude are born in the special context in cooperation and not only just individual processes. We do hard only at the job we which choose.

So, when we talk about the project, we had in mind the job, which is based on the choice of the logical way. The method of the project gives us the opportunity to use the world around us as a laboratory, in which knowledge processes take place.

The teacher must draw the attention to the next questions: 1. The problem has to follow of the experience and it must be within the jurisdiction of the student. 2. The problem must be an incentive for the student to look for information and to integrate ideas.

This is a spiral process, because it is the experience of the past and the present. We present you recommendations, which will help the method of the studying.

The members of the educational institution must take part in the educational process.

It should take place materials enriched with multimedia resources and traditional methods to reduce the difference among graduate student and their abilities.

The project-lesson assigns to the teacher and the students new tasks, which differ from traditional lessons. The learning with the project implies integration into the general education process the extracurricular institutions. The potential of the teacher and the students increase with learning the project. The lesson gives the opportunity to show the professional competences of the teacher.

OCCASIONALISMS IN ENGLISH, GEORGIAN AND RUSSIAN LANGUAGES AND ITS COMPUTER SOFTWARE

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With the help of occasionalisms a communicator has an opportunity to reveal his creative potential, which can be expressed in the intentional breaking of language norms, in order to attract listener's attention. The linguistic potential, as well as the individual's imaginative skills, is unlimited and diverse. Therefore, occasionalisms prove that a linguistic and personal creativity is boundless. As a rule, occasionalisms are eye-catching and stylistically marked. One of the most important aspects of occasionalism usage is mass media and related to it objectives. Occasionalisms are broadly used in various directions of mass media where negative or disguised information should be presented by linguistic means. So, comparing Georgian, English and Russian media

tests we have reveal some certain peculiarities. The use of occasionalisms in media discourse reflects intentional deviations, deliberate violation of norms and variation of pressure on society.

However, occasionalisms used in literature (especially, in poetry) are mostly vague; according to their content they can be metaphorical, aesthetic-expressive, melodic and require sufficient efforts to be understood. The artistic-poetic discourse in this sense is universal.

According to the examined examples of occasionalisms we can surely conclude that there are two groups of occasionalisms: 1) *The true occasionalisms* - when a content is completely new; 2) the transnomination - when a content is partially familiar. The research has shown that occasionalisms can have broad and narrow meanings. The true occasionalisms are characterized by narrow meaning, while the occasionalisms with the broad meaning contain such lexical units which were occasionalisms at the stage of their creation.

The use of occasionalisms indicates to a creativeness of a spoken language and an individual because people have an opportunity to create the linguistic units to express their own opinion. The sense of individualism and freedom makes people admire; with the help of occasionalisms they conduct communication more effectively.

A computer program has been compiled for their calculation.

CONCEPT OF FORMATION OF STIMULATING INFORMATION BASE FOR THE DECISION MAKING IN THE TOURISM SECTOR IN REGIONS OF GEORGIA AND LOCAL SELF-GOVERNMENTS

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Georgia is interesting and attractive with natural resources. It is distinguished by the diversity of agricultural products (more than 500 local varieties of vine are widespread).

There are 102 resorts in Georgia, many of them are unique. For example, there is not analogue of mineral water of Tskaltubo found in the whole world. Borjomi-like mineral water is only in France and is known as Vichy. As for socio-cultural factors in Georgia there are 12000 cultural-historical monuments, three of which are included in the UNESCO's list.

The majority of the resources listed here are located in the regions of Georgia and this fact ensures that the central government, as well as the region and municipality, must pay more attention to the creation of favorable conditions for tourists in the regions. Despite the fact that the number of international visitors by official figures in Georgia has exceeded 7,5 million in 2017, the number of problems in the management side is still high. The main problem is the lack of directed purpose and systemic nature of modern informational database or the lack of web sites. Such websites will provide foreign tourists with alternative offers from their preferred choice. In addition to improving tourism services, it would also be beneficial in a different way. For example, in correctly solved tourism development, rural areas will develop the infrastructure of the region (In service, economy, transport, infrastructure spheres). Success of tourism is directly reflected on the price of real estate in villages (price of plots, buildings), which increases capitalization of population, extends food production and processing, rises the level of knowledge and qualification of rural residents, tourism flows in regions and local self-governments. In our opinion, accurate and effective decisions made in the development of rural tourism will result in: promote development of rural infrastructure; creating additional jobs, promoting economic development; development of interesting folk crafts for tourists and others.

Targeted web sites have to include innovative tourism offers associated with ecologically clean villages and similar settlements. The information presented should reflect what the village offers to tourists: active holidays; providing ecologically clean products; recreation (restoration of spiritual and physical conditions); acquire new knowledge and experience; diversity of tourist services; closeness to nature; traditional, cultural heritage sharing.

When building web pages, we should be considered the fact that the village besides being tourist unit is a place, where there are preserved old economic traditions, local cuisine, handicraft, church celebrations, public holidays, weddings, ethnographic houses, regional museums and hospitable hosts. Those are important attractiveness and recreational resources for both local and foreign tourists.

The report will discuss the purpose of building a web site and technology, design, web page management rules, basic graphic editor, effective technology for animation and video clips.

MODELS AND ALGORITHMS OF SMART ENTERPRISE

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The aim is to develop a new approach for enterprises operation in the highly dynamic environment of changing production, technological, and business processes in the digital economy. The concepts and technologies of a smart enterprise creation are suggested. The smart enterprise is considered as a production innovation based on the high level of knowledge about the system, highly productive methods of intellectualization of management processes and models of creative thinking. Also it is characterized by creating the concept, model and way of functioning in different industries. The smart enterprise is a flexible system with the Distributed Artificial Intelligence for industrial automation that provides an enterprise with the efficient functioning and support. In such system a flexible distributed model is a basic component alongside with universal use of the miniature mobile devices, wireless networks, satellite navigation systems for “cloud” calculations, information depositories, electronic environment, that creates the image of surrounding objects and processes. This model runs all processes in real time and reflects mentation processes supported by powerful software tools. The management system uses the concept of creative thinking. It represents the set of scenarios that allow processing the image of the controlled process in order to get an appropriate image of controlling operations. The control image reflects the general purpose of the management system. It is divided for numerous scenarios corresponding to the separate functions of the management system. Theses scenarios are interconnected so as they operate as separate links of a general algorithm in certain production situations. Thus, the set of separate scenarios function not in a fixed sequence (one by one) and not chaotically but they are set in different chains depending on the changing image of the production situation. All functions realized in the control system are divided into information and controlling ones. Summary The smart enterprises of the digital economy especially need artificial intelligence systems. There is still a certain gap between development works, artificial intelligence software and possibilities of their widespread adoption into practice.

IDENTIFICATION OF COGNITIVE MAPS UNDER UNCERTAINTIES

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Identification problem is one of the major problems in cognitive modeling. Usually weights of cognitive map (CM) edges are set by experts based on their knowledge and opinions; there are different methods of aggregating experts' estimates. But anyway adequacy of these expert weighting coefficients are questioned. So it is desirable to get mathematically precise methods of estimating them based on measurements of CM nodes coordinates. At the present moment very few researches are dedicated to this issue.

In this report we consider several cases. The easiest one is the case when all nodes are measured precisely. Then the only requirement for successful identification is to have at least n discrete observations available where n is number of CM nodes. If it is fulfilled we can identify all edges weights with very high precision using least squares method [1].

The second case is when all nodes are measured but with noise. Here several approaches are proposed. The first one utilized combinatorial method [2] which provides highly precise results but is applicable only if respective observation matrix is well-conditioned. The second approach is more general and can be solved using least squares method (possibly weighted). The third approach is based on regularization theory. It should be applied if the problem is ill-posed or if we have additional information about the problem (i.e. if we know which edges are absent, i.e. have zero weights) [1].

The third case is the most difficult. If not all CM nodes can be measured and we actually don't know the whole structure of CM. The idea is to create equivalent system in sense of measurable outputs and to identify its coefficients instead of the initial CM identification.

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ON A FUNDAMENTAL SOLUTIONS OF SOME FRACTIONAL DIFFERENTIAL EQUARONS

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It is known that for the ordinary differential equations fundamental solutions are understood as “independent solutions”. Generally if we put the fundamental solution into the equation then the right hand side should be equal to Dirac’s $\delta(t)$ - function. Here we consider fundamental solution for the fractional differential equation using Riemann-Liouville definition.

It is known that Heaviside’s unit function is of the form

$$\theta(t) = \begin{cases} 1, & t > 0, \\ \frac{1}{2}, & t = 0, \\ 0, & t < 0. \end{cases} \quad (1)$$

Its derivative is indeed Dirac’s delta function.

If the function $f(x)$ is defined in the interval $[a, b]$ then

$$D_{a+}^{\alpha} f(x) = \frac{1}{\Gamma(1-\alpha)} \frac{d}{dx} \int_a^x \frac{f(t) dt}{(x-t)^{\alpha}}, \quad (2)$$

$$\text{or} \quad D_{a+}^{\alpha} f(x) = \frac{d}{dx} \int_a^x \frac{(x-t)^{-\alpha}}{(-\alpha)!} f(t) dt. \quad (3)$$

Here (2) and (3) are fractional derivatives in sence of Riemann-Liouville.

Now let’s define fundamental solutions for the fractional equations with $\frac{1}{2}, \frac{1}{3}, \frac{3}{7}$ and any $\forall \alpha \in (0,1)$ order. To do this we use Riemann-Liouville formulas and Euler’s gamma function.

$$\Gamma(t) = \int_0^{\infty} x^{t-1} e^{-x} dx, \quad \text{Ret} > 0, \quad \Gamma \text{ is Gamma function}. \quad (4)$$

We find fundamental solution for the $\frac{1}{2}$ order equation.

For the first order equation fundamental solution is indeed the Heaviside function

$$\begin{aligned}
D^{\frac{1}{2}}U(t) &= \delta(t), \quad D^{\frac{1}{2}}(D^{\frac{1}{2}}\theta(t)) = \delta(t), \\
U(t) &= D^{\frac{1}{2}}\theta(t) = \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{1}{2}}}{\left(-\frac{1}{2}\right)!} \theta(\tau) d\tau = \\
&= \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{1}{2}}}{\left(-\frac{1}{2}\right)!} d\tau = -\frac{d}{dt} \frac{(t-\tau)^{\frac{1}{2}}}{\left(\frac{1}{2}\right)!} \Bigg|_{\tau=0}^t = \frac{d}{dt} \frac{(t)^{\frac{1}{2}}}{\left(\frac{1}{2}\right)!} = \frac{t^{\frac{1}{2}}}{\left(-\frac{1}{2}\right)!}.
\end{aligned}$$

Thus

$$U(t-\xi) = \frac{(t-\xi)^{-\frac{1}{2}}}{\left(-\frac{1}{2}\right)!}. \quad (5)$$

For the $\frac{1}{3}$ order equation

$$\begin{aligned}
D^{\frac{1}{3}}(D^{\frac{2}{3}}\theta(t)) &= \delta(t), \quad D^{\frac{1}{3}}U(t) = \delta(t), \\
U(t) &= D^{\frac{2}{3}}\theta(t) = \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{2}{3}}}{\left(-\frac{2}{3}\right)!} \theta(\tau) d\tau = \\
&= \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{2}{3}}}{\left(-\frac{2}{3}\right)!} d\tau = -\frac{d}{dt} \frac{(t-\tau)^{\frac{1}{3}}}{\left(\frac{1}{3}\right)!} \Bigg|_{\tau=0}^t = \frac{d}{dt} \frac{(t)^{\frac{1}{3}}}{\left(\frac{1}{3}\right)!} = \frac{t^{-\frac{2}{3}}}{\left(-\frac{2}{3}\right)!}
\end{aligned}$$

or $U(t-\xi) = \frac{(t-\xi)^{-\frac{2}{3}}}{\left(-\frac{2}{3}\right)!}. \quad (6)$

For the $\frac{3}{7}$ order equation

$$D^{\frac{3}{7}}(D^{\frac{4}{7}}\theta(t)) = \delta(t), \quad D^{\frac{4}{7}}U(t) = \delta(t),$$

$$\begin{aligned}
U(t) &= D^{\frac{4}{7}} \theta(t) = \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{4}{7}}}{\left(-\frac{4}{7}\right)!} \theta(\tau) d\tau = \\
&= \frac{d}{dt} \int_0^t \frac{(t-\tau)^{-\frac{4}{7}}}{\left(-\frac{4}{7}\right)!} d\tau = - \frac{d}{dt} \frac{(t-\tau)^{\frac{3}{7}}}{\left(\frac{3}{7}\right)!} \Bigg|_{\tau=0}^t = \frac{d}{dt} \frac{(t)^{\frac{3}{7}}}{\left(\frac{3}{7}\right)!} = \frac{t^{-\frac{4}{7}}}{\left(-\frac{4}{7}\right)!} \\
\text{or} \quad U(t-\xi) &= \frac{(t-\xi)^{-\frac{4}{7}}}{\left(-\frac{4}{7}\right)!}. \tag{7}
\end{aligned}$$

Finally for any $\alpha \in (0,1)$ order differential equation the fundamental solution is in the form

$$\begin{aligned}
D^\alpha (D^{1-\alpha} \theta(t)) &= \delta(t), \quad D^\alpha U(t) = \delta(t), \\
U(t) &= D^{1-\alpha} \theta(t) = \frac{d}{dt} \int_0^t \frac{(t-\tau)^{\alpha-1}}{(\alpha-1)!} \theta(\tau) d\tau = \\
&= \frac{d}{dt} \int_0^t \frac{(t-\tau)^{\alpha-1}}{(\alpha-1)!} d\tau = - \frac{d}{dt} \frac{(t-\tau)^\alpha}{(\alpha)!} \Bigg|_{\tau=0}^t = \frac{d}{dt} \frac{(t)^\alpha}{(\alpha)!} = \frac{t^{\alpha-1}}{(\alpha-1)!} \\
\text{or} \quad U(t-\xi) &= \frac{(t-\xi)^{\alpha-1}}{(\alpha-1)!}. \tag{8}
\end{aligned}$$

DISTRIBUTION OF EXPENSES IN LOGISTIC COOPERATIVE GAMES WITH RESTRICTED COOPERATION A.U. Hmyria

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Using of the theory of cooperative games in applied problems makes it possible to create methods for modeling many situations of decision-making under conditions of conflict [1,2]. However, most of the problems that are considered in the theory of cooperative games have a full set of coalitions. In practice, this condition may sometimes not be fulfilled, because some coalition can not be created for technical,

political or other reasons [3]. These actual problems of the theory of games in the context of logistics problems are discussed in the report.

The report describes a transport problem with a set of carriers. It is formulated as a cooperative game. The characteristic feature of this game is determined. The task of finding the distribution of minimum total costs is solved for both classic and restricted cooperation games of players. To solve both problems, the concepts of the C-core and Shapley value were used. According to the concept of the C-core, an egalitarian distribution of costs was built. The Shapley value leads to a utilitarian distribution of costs.

This approach was tested on model examples of logistics problems. A comparative analysis of the obtained results was carried out. These results, which were obtained for both tasks, showed the expediency of cooperation between players.

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CREATING AN AUTOMATED SYSTEM FOR TRADING ON THE STOCK EXCHANGE USING TECHNICAL ANALYSIS

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Nowadays technical analysis becomes more popular in trading system design. When internet-trading was launched in Ukraine, trading on the stock exchange became available for lots of people. Therefore, it is necessary to create a system, which will generate buy or sell signals based on combination of technical analysis trend-following indicators and oscillators.

The study focuses on popular trading indicators such as Average directional index (ADX) indicator, Aroon indicator, indicators based on moving averages, Stochastic oscillator, Relative strength index (RSI) and %R Williams oscillator. The research shows that almost all indicators use only moving average, but not standard deviation, which is

very important statistical characteristic of a price range. Consequently, a new algorithm is created in order to indicate the trend direction.

Algorithm bases on calculation of moving average $EMA_t = \alpha p_t + (1 - \alpha) EMA_{t-1}, 0 \leq \alpha \leq 1$ and moving deviation

$\tau = \sqrt{\frac{(p_t - EMA_t)^2}{n-1}}$, where p_t is current close price, n – period of moving average. If $|p_t - MA_t| > \tau * m2$ then:

- a) If $p_{t-i} - MA_{t-i} > \tau_{t-i} * m3$ for every $i = \overline{1..r}$ and
 - $p_t - MA_t > \tau * m1$ then signal “UP”
 - $p_t - MA_t > \tau * m2$ then signal “WARNING UP”
- b) Else If $p_{t-i} - MA_{t-i} < -\tau_{t-i} * m3$ for every $i = \overline{1..r}$ and
 - $p_t - MA_t < -\tau * m1$ then signal “DOWN”
 - $p_t - MA_t < -\tau * m2$ then signal “WARNING DOWN”
- c) Else if $p_t - MA_t > \tau * m2$ then signal “LIGHT WARNING UP”
- d) Else if $p_t - MA_t < -\tau * m2$ then signal “LIGHT WARNING DOWN”
- e) Else signal “NON”

Oscillator's signals interpretation is shown in terms of classical technical analysis in literature. Since it is hard to implement this interpretation programmatically, formal interpretation of oscillator's signals is created by building an automaton, which has 9 states. Automaton generates sell and buy signals for certain transitions between states.

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ABOUT MATHEMATICAL MODEL OF ADVERTISING DIFFUSION PROCESS

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It is generally believed that calculating the effectiveness of advertising is a rather complex problem. But absolutely everyone is of the opinion that it is necessary to measure the effectiveness of advertising. Advertising is "the art of implementing a unique trade offer in the head of the largest number of people at the lowest cost": if you do not care about minimizing advertising costs, then this process will be more than a complete squandering. On the other hand, minimizing costs without calculating efficiency is impossible.

The main problem of determining the optimal advertising budget is to determine the budget, which would allow getting a guaranteed return on advertising. Any deviation from optimality leads to inefficiency [1]. In fact, the essence of the effectiveness of advertising is to assess the magnitude of the positive shift in relation to the buyers of the subject of advertising and depends on the trade proposal, the form of its presentation (creativity), the use of advertising carriers and the frequency and duration of the action of advertising on buyers.

Assuming that the advertiser has a good trade proposal, developed forms of its submission, for which media are used, we simulate the process of spreading the action of advertising to customers. We use for this purpose a description of the change in the concentration of the effect over time. One approach that is used to evaluate the effectiveness of advertising activities on its outcome is to simulate the process of spreading influence over schemes similar to diffusion models.

The paper suggests an approach to modeling the level of the impact of advertising on the awareness of the public about the advertised product. Based on the approach according to which this process is considered similar to the diffusion process, mathematical models of a hybrid type are obtained. Models are considered in conditions of population change and changes in the number of goods. Numerical experiments were conducted on specific examples.

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ABOUT HYBRID MATHEMATICAL MODEL OF INFORMATION DIFFUSION PROCESS

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Information flows are processes that generate information that is designed for a specific consumer, has, as a rule, a clearly defined objective or target orientation, which is determined by the area of human interests. At the same time, the amount of information obtained significantly exceeds our consumer capabilities. Different versions of ideas and opinions must compete for the consumer's limited attention, given the complex changes in the consumer environment. And, as a consequence, special interest is given to methods that investigate and use models of dynamics to describe information dissemination processes.

It is obvious that in order to formalize and study the development of information impact on society in time, it is necessary to use a fundamentally new tool that will adequately reflect the state of the dynamic component of the information dissemination process [1]. At the same time, the development of new approaches does not abolish the methods of using classical methods of analysis and processing of information processes, which is postulated in the form of a so-called mechanistic approach.

The paper considers one of the ways of formalizing information processes, based on the use of hybrid models of diffusion (penetration) and dissemination of information in a certain target group. To describe the spread of information influence, mathematical models of diffusion-type dynamics were proposed and investigated using models of infectious and chemical reactions.

The proposed technique allows one to describe the levels of influence and storage of information based on the solution of the diffusion equation, the variation of the propagation intervals in which is modeled with the help of additional relations in the form of differential equations. Examples of the use of this approach are given, the results of numerical experiments are analyzed.

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ANALYSIS OF THE RELATIONSHIP BETWEEN USDX AND GOLD PRICES IN R

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This article focuses on the relationship between USDX and Gold Prices in R language and environment be used. The aim of this article is to analyze and determine the character of the co-movement between price levels. In this paper the relationship between USDX and Gold Prices was analyzed by BDS test, non-linear ARDL approach and two non-linear Granger causality methods from 2010.01.01 to 2018.01.01. This article also presents the basic characteristic and determinants of current price trends.

Typically, any change in the USDX index movement allows anticipate the trend of foreign currency assets, which are directly linked to the US dollar, but it's basic or as they say in the Forex, major pairs. Some of them with growth USDX will also show an increase in value, it is, for example, USD / JPY, USD / CAD, USD / CHF.

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THE INDICATOR MECHANISM OF CITY'S SOCIAL-ECONOMIC POTENTIAL MANAGEMENT CONTRIBUTING TO THE DECISION-MAKING

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The current economic reforms in Georgia have faced a new problem in the management of the urban economy, which in turn has made the management decision-making difficult and has resulted the ineffective decisions. Therefore, nowadays the issue of considering the socio-economic development of the city in a complex point is very crucial. One of the ways to solve this problem is to develop the city's indicator management mechanism. As it is known, the indicator management is mainly considered as the economic indicators' research-based management activities. The analysis of the indicator management principles and mechanisms shows that it represents the interaction of state and non-state bodies' interests. The coordinated action contributes to the self-regulation processes of market and non-market economics, which aims at the urban socio-economic development. Thus, the indicator management represents a set of procedures supporting the harmonization of reproductive processes, which are realized at the different levels of city governance.

In our case, while processing the indicator management mechanism, the comparison of indicators systems is conducted that is given in the quantitative and qualitative units. This can be the economic situation of the city, quality of people's life, etc. The indicative planning and management is the city's socio-economic regulation by the self-government bodies. The management body is actually an indicator management unit, which is based on a number of criteria and serves for one purpose - the socio-economic development of the city.

One of the problems with indicator management mechanism is the formation of indicators. The indicators formation is not standardized and should be determined by the reliable source, such as the statistical data, different services and institutions, administration, departments of the city, etc.

The following key factors should be considered within the system approach when elaborating the indicator mechanism for solving the city's socio-economic potential and management decisions[1]:

C - Key features (structure, type, power, etc.);

S - Structural factors (links, attitudes);

F - Functional factors (potential functions, comparison of functions, identification of functional structure);

I - Integration (determination and solution of contradictions);

H - Hierarchy (potential levels, ties with levels).

Therefore, the management decision making indicator mechanism will be defined on the following set:

$$M = \{G, S, F, I, H\}.$$

In the report, the algorithms of the indicator mechanism of assessing the socio-economic potential of the city on the set are discussed. The main focus in the algorithm is made on the concept of urban development macro-module, the development assessment indicator system, the base model of the decision-making indicator mechanism.

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THE TYPES OF THE DECISION-MAKING IN THE ELECTRONIC OFFICE

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The modern electronic office is the traditional extension of the important centre of early period activity and correspondence, without which an institution cannot function. An office manager is the office's key figure, who organizes the office documents (collecting, classifying, storing, transmitting and distributing documents), arranges the meetings, negotiations, internet conferences, and regulates many small things, details, or important issues that the office serves.

The office manager is directly involved and manages the decisions' implementation, which are made by the head of the institution, the owner or the other authorities. The electronic forms and methods of decision-making and implementation or decision-making support systems play an important role in this process. The immediate purpose of these systems is the alternative set formation of decisions, which is a set of individual contradictory possibilities – decision options. In most

cases, the alternatives do not have the structure or it is non-structured, and in order to successfully solve the decision-making task, it is necessary to structure the set of the mentioned alternatives in any way: classification, stratification, and rankings. It is obvious that this technology is based on the use of information systems and networks that significantly contributes to the result-oriented, effective decision-making process.

The goal of our research is to introduce the electronic governance contributing to the functioning of bureaus of the Members of Parliament of Georgia. The effective implementation of the functions of a MP and the relevant decision is impossible without the existence and complete analysis of the problems of the voters. It is obvious, the analytical information for the Bureau of Deputies is the voters' information sent in the written or different communication means, which includes the general information according to any topic. This notice requires the identification at first, and then its target procession on the purpose of formation of the relevant database, the so-called demands base. The final and most important of this sequence for the deputy is to prepare a qualified conclusion to carry out the relevant action. The conclusion is formed as a result of the analysis of the received materials, the text should be short and logical, covering the prognosis with relevant recommendations.

The analysis of the results of our research showed that in many cases, the problem of citizens cannot be solved by deputies due to improper functioning of the offices of the bureau and the problems being redirected to another state body. The main reason of improper functioning of offices is the absence of database supporting the functioning of the Bureau of Deputies.

The automated management system of the Bureau of Deputies, which will be designed for modern methods of decision-making, will have a practical use, not only in parliamentary activity, but it will be used effectively in the office of any enterprise, institutions, public administration, business structures, and educational institution, etc.

In the report, the following issues are reviewed:

- ❖ Organizational forms and peculiarities of office decision making.
- ❖ Identification of automated management tasks for office service.
- ❖ Conception of building the automated management of office services.
- ❖ Selection and identification of the main factors of office decision making according to priorities.

- ❖ Office decision-making methods and instruments.
- ❖ The example of the information base formation contributing to the decision-making in the aspect of voters' demand and election promises.

OBJECT-ORIENTED, DECISION-MAKING MATRIX SUPPORTING WEB-PAGE CLASSIFICATION

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Our study concluded that current websites on internet lack proper classification and structure, which creates certain informative chaos, duplication and excess of information. In this kind of cases, customer has a trouble identifying a correct path to the search results. Based on an analysis of current situation we concluded, that its important to come up with a more sophisticated website classification model, which would organize an information field based on its primary characteristics.

Website classification problem can be discussed as subjective or functional classification, also as classification based on object-oriented characteristics etc. We highlight object-oriented characteristics for website classification, detailed features of different subject matter are determined, that's exactly what distinguishes websites from each other.

Our suggested model for website classification draws attention to its purpose and sensitivity of the information. We offer generation method of decision making matrix for creating multi-functional websites in a classified environment. This matrix might determine particular class of a webpage and its minimal standards, which would make a presence of this page in particular class legitimate. Creating a decision-making matrix that supports classification is discussed as a problematic task.

Let's give it a formulized representation of a problem and use following designations:

$D_i, i = \overline{1, n}$ - predefined multiplicity of web-page categories;

$C_j, j = \overline{1, m}$ - multiplicity of classified web-pages;

$A = D \times C$ - represents M matrix for classification.

$$M = \begin{matrix} & c_1 & c_2 & c_3 & \dots & c_m \\ \begin{matrix} d_1 \\ d_2 \\ d_3 \\ \dots \\ d_n \end{matrix} & \left| \begin{matrix} a_{11} & a_{12} & a_{13} & \dots & a_{1m} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2m} \\ a_{31} & a_{32} & a_{33} & \dots & a_{3m} \\ \dots & \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & a_{n3} & \dots & a_{nm} \end{matrix} \right| \end{matrix}$$

Every a_{ij} element of M matrix is determined as follows:

$$a_{ij} = \begin{cases} 1, & \text{if } d_i \in C_j; \\ 0, & \text{otherwise.} \end{cases}$$

Therefore, M matrix enables us to make decisions regarding a class that should be assigned for different web-pages.

Furthermore, I state that web-page could be of different classes simultaneously, for example it could be educative, scientific or educative-scientific in nature etc. This is caused by a topic based classification system, which is associated with web-page owner, choice of particular topics, content of the information, its purpose and customer. Decision-making matrix suggests broad range of alternative classification systems to a decision-making person. In this particular case choice is made by the same decision-making person.

MINIMAX ESTIMATES OF SOLUTIONS OF THE FIRST ORDER LINEAR HYPERBOLIC SYSTEMS UNDER UNCERTAINTIES

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In this paper, we focus on the optimal estimation of solutions of the Cauchy problem for the first order linear hyperbolic equation systems (or, more generally, estimation of values of some functionals on their solutions) under incomplete data. Such problems appear in the frequent situation when the right-hand sides of the equations and initial conditions are not known exactly but only satisfy certain restrictions.

We assume that right-hand sides of equations and initial conditions are unknown and belong to the given bounded subsets of the space of all

square integrable functions. For solving such problems with the lack of reliable information about the distribution of random perturbations, the following approach is used. We are looking for linear with respect to observations optimal estimates of solutions of the considered equations systems from the condition of minimum of maximal mean square error of estimation taken over the above subsets. Such estimates are called minimax estimates. This approach makes it possible to find optimal estimations of unknown solutions, corresponding to the “worst” cases of perturbations.

We elaborate constructive methods for obtaining such estimates, which are expressed in terms of solutions of special integro-differential equations.

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SYSTEMIC APPROACH TO MAKING DECISIONS IN THE SERVICE STRATEGY OF AIRPORT PASSENGERS

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Nowadays, airports are managed by the joint processes of high standard conception and passengers' service. On the one hand, the processes which are included in the functions of passenger service are easily perceived, but on the other hand, they require great responsibility and in some cases they are non-standard – they require solving uncertain tasks. Obviously, when solving these tasks and corresponding problems, systematic approach leads to high results.

There are extremely varied processes ongoing at the airport, from loading the plane, receiving luggage to managing the passenger flow.

The task of the airport service workers is to coordinate and optimize the activity of different firms and organizations involved in the implementation of flights; offer appropriate services to the passengers. All the organizations involved in this process should work systematically, in close cooperation, without fail, in order to provide safe and high standard service. It must be mentioned that organizing daily flights means extreme fluctuations. For example, at the airport, the logistics of loading and unloading the plane differs from other types of work and is planned in details, and each detail has a vital importance. Therefore, each separate requirement or process which is connected with passengers is constantly under control of a corresponding service (Change Management). It is clear that the airport must have a strong communication network, which enters the system, provides high quality functioning in continuous mode and reacts to all messages. For this, the airport must have modern technologies and progressive, flexible informational (electronic) logistics which support decision making process. The highest level of high-quality, high-tech logistics method is the creation of information-technological system for boarding logistics. The complex process which provides boarding, luggage delivery or shipping for a particular flight is agreed with the partner airline. One of the most important issues at the airport is to make decisions in managing the implemented processes in accordance with the modern requirements and dynamics. Among the main processes, we will discuss loading and unloading works which comprise services of passengers, luggage, mail and different loads. The requirements which are connected with the listed processes must be done as quickly as possible and on time in order to avoid delay and unreliability. The data necessary to make decisions must be released and received on time, without delay. The processes in the system are focused on the quickness of decision-making and processing of information. At the same time, the deficit of resources, power and time are taken into account.

It is evident that the continuous and undeterred flow of data is provided when all directions are coordinated in the logistics network. The airport is obliged to unite external partners in the system conception. In order to achieve this, it is necessary to connect sub-systems with common approaches in logistics system. The activity of the functions and separate organisations must be united into one whole conception. This way, the changes will be reflected in the whole system, which will provide transparency and availability.

Within the presentation we will discuss:

- ❖ Systematic approach to making decisions in organising departures and arrivals of aircrafts. This approach implies implementation of the processes based on the task flow organised in accordance with definite rules.
- ❖ Problems of using technological systems of high level mass service while making decisions; the issues of automatization of logically connected processes and spreading information.
- ❖ Making accurate and strictly defined decisions in logistics in uncertain situations (DECISION MAKING UNDER UNCERTAINTIES), such as: change of flight, resource deficit, different deterrent factors, etc.

BENEFITS AND RISKS, DEVELOPMENT PROSPECTS OF CLOUD COMPUTATION

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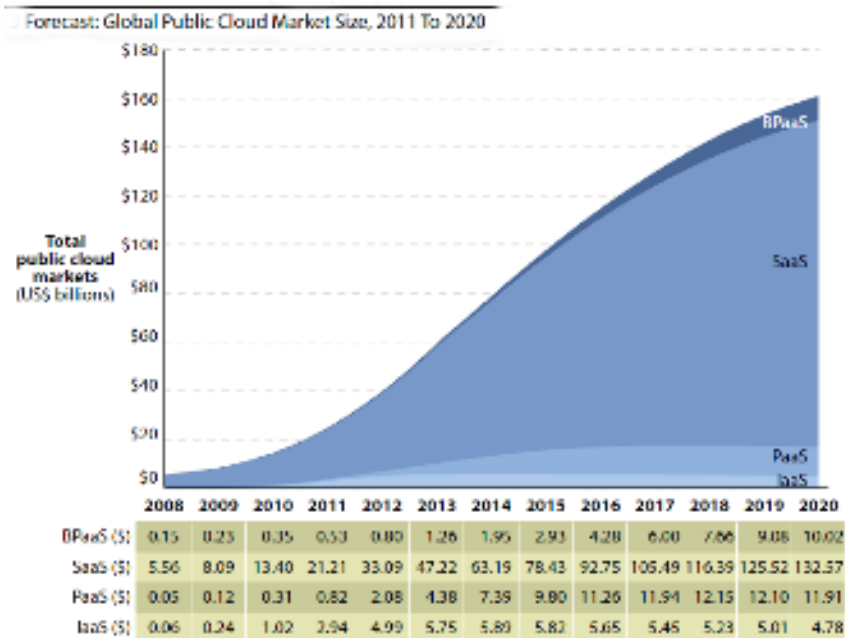
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Cloud computation is "Data Distributed Technology, where computer resources and capabilities are offered for the Internet service." Internet service also means web technologies in the local network.

The development of cloud computing was contributed not only Google and Amazon offered internet service, but also technical progress in general. In particular, the creation of multi-core processors contributed to the increase of productivity, increase the capacity of the information carriers, contributed to increased storage capacity of the storage and also reduced the costs of its services.

Benefit:

1. Availability
2. Reliability;
3. High speed processing of data;
4. Lower IT operating costs.



Risks:

1. The data storage and security depends on the service supplier;
2. The necessity of staying in the network;
3. The appearance of "cloud" monopolists;
4. Cost of equipment for creating your own "cloud".

The forecast of analytical companies "Forester Research" is that the market of cloud calculations by 2020 will reach \$ 160 billion. (fig 1.) In the future, "cloud computing" will be interesting to many organizations due to the following conditions: serviceable virtualization, reduction of hardware power equipment, speed increase. Cloud technologies are at the primary stage. Many projects are still far from the latest versions, users and manufacturers are not fully familiar with and do not trust this technology. Also, the standardization of services has not been fully developed, it has not been determined which direction of the technology will be more promising and commercially viable.

One of the factors behind the delay of cloud technologies can be the legal and judicial side. For example, "clouds" should correspond to those legislative acts on the territories of which they are located. On the other hand, the use of the "cloud" is possible from anywhere in the

world, that is, from another country. Cloud technology is actively developing, and the market is growing. The increase in computing capacity and the development of network technologies help create centers of collective services, where terminal implementation will be used. In accordance with the announced Cisco account in 2012, the use of servers with network traffic reached 60%. In the future, the network load on the media service will increase especially.

In different spheres, the use of cloud technologies is not implemented unambiguously. For example, in banking and financial activities, due to the name of the information security of the Public Cloud, the Personal Cloud prevails, which maximizes the information security of bank data and the ability to manage independent individual systems.

Special opportunities are provided by the use of the "cloud" in the scientific and educational sphere. In particular, it is possible:

1. It is possible to create a web-oriented laboratory in a specific subject;
2. Use of new opportunities to disseminate the results of research and development of scientific problems;
3. Transfer lectures-seminars and laboratory works to different directions.

Proceeding from this, cloud computing has a good perspective in the educational and scientific fields.

Conclusion. Cloud computation is a promising trend and highly likely to be widely used in the future. Using of Cloud Computing reduce information technology, infrastructure and staff costs. it will be able to access easily to the desired services, which are placed in the "cloud". However, due to less protection of the public cloud, the another person can make an unauthorized access to the cloud services. that is why, the cloud services are less usable for saving confidential data.

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INTERDISCIPLINARY MODELLING OF TEACHING, AS THE BASIS OF THE PERFECT DECISION-MAKING

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The interdisciplinary process modelling of teaching means the consideration of educational work and related activities in one systemic integrity.

The interdisciplinary process modelling of teaching is characterized with the high level of difficulties and is actually a nonlinear dynamic system. The goal of interdisciplinary is to identify and understand the current links between different learning subjects and science. This process, besides being an important means of solving the teaching didactic problem-solving, serves for the integration and differentiation of science, which is very important for adequately understanding and studying the events in the surrounding world.

The most important thing is that the integration of interdisciplinary knowledge and skills helps the graduates of higher institutions to make the perfect decision in the future practical, entrepreneurial, scientific and social life [1].

The integration of knowledge through the interdisciplinary links ensures the ability to see and solve problems and processes at the new level. Thus, the interdisciplinary teaching is the main trend that determines the cognitive processes, which should be presented within systemic law. Therefore, the interdisciplinary union is perceived as not any unity of two different teaching disciplines or scientific direction, but as the fundamental direction of scientific research for defining and establishing the new system of knowledge. This new system of knowledge is presented not as in the aspects of the individual elements and their functioning, but their agreed and purposeful work. For all these, the following should be defined at the scientific level: the essence and educational purpose of interdisciplinary links; the interdisciplinary educational character and direction; the methodological problems of interdisciplinary researches; the development perspectives of interdisciplinary links.

Finally, the interdisciplinary links are the main basis of interdisciplinary methodology. This determines the formation of interdisciplinary links, which knowledge of other disciplines should be used to study the subject, which law, method and theory of other

disciplines are applicable to it. This is the problem towards teachers, who should make a decision on interdisciplinary implementation.

In the report, there are given the:

- ❖ Discussion of interdisciplinary modelling problems of teaching in pedagogical theory and practice.
- ❖ The main tasks of modelling the educational process based on the interdisciplinary integration.
- ❖ Description of the organizational and pedagogic conditions of interdisciplinary integration.
- ❖ Decision-making algorithm in the formation and realization of interdisciplinary links.

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METHOD OF CHARACTERISTIC FOR THE EQUATIONS OF FORMATION OF WATER FLOWS IN RIVERS WITH UNEVEN BOTTOM

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The work [1-3] describes the use of a system of equations that follow from the general laws of conservation of momentum and mass, for the description of the flow of water in the open pseudoprismatic channel (Fig. 1).

It has the following appearance

$$\frac{\partial u}{\partial t} + \frac{1}{B} \frac{\partial f}{\partial x} + \frac{u}{g} \frac{\partial u}{\partial x} + \frac{u^2}{C^2 R} = i; \quad (1)$$

$$\frac{\partial f}{\partial t} + u \frac{\partial f}{\partial x} + f \frac{\partial u}{\partial x} = 0, \quad (2)$$

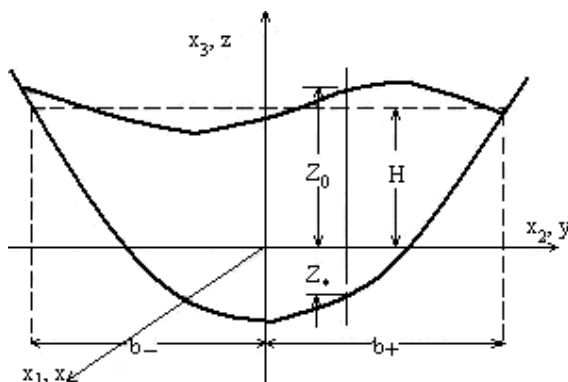


Fig. 1. Cross section of the channel flow.

where u - speed of flow of water, f - cross-sectional area of water, B - width of the channel, C - coefficient of Chezy, R - hydraulic radius, $i = i(x)$ - external fluid inflow (lateral influx).

Using the method of obtaining characteristics for the equations of Saint-Venant [4] and some mathematical transformations and simplifications for (1) and (2), we obtain the following relations:

$$\frac{\partial u}{\partial t} + (u + \bar{u}) \frac{\partial u}{\partial x} + \frac{\bar{u}}{f} \left[\frac{\partial f}{\partial t} + (u + \bar{u}) \frac{\partial f}{\partial x} \right] = ig; \quad (3)$$

$$\frac{\partial u}{\partial t} + (u - \bar{u}) \frac{\partial u}{\partial x} + \frac{\bar{u}}{f} \left[\frac{\partial f}{\partial t} + (u - \bar{u}) \frac{\partial f}{\partial x} \right] = ig. \quad (4)$$

Let's put in (3), (4) $\bar{u} = \sqrt{\frac{gf}{B}}$. Then we have in (3), (4) positive and negative characteristics:

$$\frac{dx}{dt} = u + \bar{u}, \quad \frac{dx}{dt} = u - \bar{u}.$$

In the role of the speed $\bar{u}$ of flow, which is directed behind / against the direction of the flow of water in the river channel.

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INFLECTION GRAMMARDICTIONARY DEVELOPMENT FOR SYSTEM OF AUTOMATED TRANSLATION INTO SIGN LANGUAGE

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Development of Ukrainian grammar dictionary based on inflection formal model [1], according to which whole set of words is divided into certain mutually disjoint subsets, within each of them the inflection occurs according to the same rules, is proposed. The subsets of words with such properties are called inflection paradigmatic types. Seven paradigmatic types are identified and studied for Ukrainian language. Instead of word itself a basic word form number out of corresponding set of basic wordforms, position number in the word to which the basic wordform is unchanged and flexion number (variable part of the word) from corresponding set are stored in database, and that is an advantage of such word storage model. Structure of sign language dictionary consists of gestures set and non-manual markers that convey mimic and emotional components of gesture. Method of translation is constructed by obtaining mutually unambiguous pairs conveying meaning: a sentence in input language into corresponding sentence in sign language. By defining order of location of words in input sentence, structures (generalizations) with sets of words (given by inflection parameters) placed instead of specific words in sentence, were obtained. Similar structures are under construction for gesture sentences as well. Thus, volume of grammatical constructions for translation is rather small (relatively to the total number of

sentences). To distinguish simple structures of sentences from the input text the authors propose to consider tensor approach [2], applying of which allows transmission of semantic information rather than not typical for the communication in sign language sequential-verbal one.

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OPTIMAL SYNTHESIS OF THE FEATURES VECTORS FOR DATA CLASSIFICATION

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Problem of the characteristic features space analyzing is the primary and decisive in the processes of information classification. The effectiveness of the classifier using depends on the completeness of information about the classes and not redundancy of the features space. Spending for measuring or calculating of the some features can be significant, so the selection of attributes is an important aspect of the classifier training and using. It is advisable to ignore, for example, noisy and not informative features. The optimal selection of components of the features vectors can provide an acceptable rate of execution of classification algorithms. To solve these problems, ideas for hyper plane classification and clustering [1,2] have been used, which provide an explicit form for the conditions of the separation of sets for the correspondence distances between sets of vectors of features and hyper planes.

In the report, using pseudo-inversion tools, some approaches to optimizing feature spaces are considered.

Features sequential analysis. The algorithm is sequentially using the direct formulas of Greville-Kirichenko, adding to the set one by one the signs, including the set of only those features, which leads to an increase in the distance between the hyper planes of the classifier.

Gradual removal of features. If a hyper plane classifier has already been constructed, but there was a need to improve it, it is expedient, using Greville-Kirichenko's inverse formulas, to remove those features that leave the unaltered distance between hyper planes increasing.

The feature space supplementing. Optimally determine the linear combination of informative features to expand the classifier's band.

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HYPERPLANES CLUSTERS IN SPACES OF SIGNS VECTORS

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When solving various applications of digital processing of information, a wide range of possibilities of using the concept of pseudo rotation of matrices is appeared for the development of mathematical methods of clustering and classification of information [1] - [4]. Using of elementary linear structures - hyperplanes - with simple relations for distances between vectors and hyperplanes, between sets of vectors and hyperplanes in the spaces of characteristics, in conjunction with the results of the theory of perturbation of pseudo-inverse, projective and R-matrices [1], [2] provides not only the construction of effective algorithms for solving problems, as well as opportunities of their optimization within the framework of their specific statements. The hyperplanarclusterization variant is related to [3], [4]. Within the framework of this variant the description of hyperplanes is carried out through the hyperplanes, which are solutions (pseudo-solutions) of systems of linear algebraic equations (in this case, there is a problem of finding the optimal elements of such systems of linear algebraic equations - the main matrix, vector of right-handed parts, for which algorithms of their calculation are presented). In [2], the parameters of the hyperplanes are recurrent according to the acceptability functional of the presented partition. The acceptability functionals are one or another

variant of the distance of the cluster element to its hyperplane, the distance of the cluster element to the hyperplane of another cluster. Euclidean distances were used as distances, and as a measure of the compactness of a hyperplane cluster, the dispersion of cluster elements relative to its hyperplane was used. As an effective solution to the problem of dispersion minimization of cluster elements, a variant of the hyperplane cluster can be used, which would be described not by one hyperplane but by a few hyperplanes, that is, a piecewise hyperplane cluster is constructed. This idea of a piecewise hyperplane cluster stems from the proposed approach of solving the problem of the piecewise linear separation of the set of points in the space of the vectors of characteristics from the origin, which was proposed by Professor Kirichenko M.F. in 2007 [1].

In the report, the presentation of the results on the topic of a piecewise hyperplane clustering of information is given after a brief description of the mathematical results regarding the definition of pseudo-inversion, formulas of calculating pseudo-inverse, projective and R-matrices when resizing the dimension of the output matrices. Different variants of distances between elements of vector spaces are given.

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ANALYSIS OF STATIONARY REGIME FOR THE $[SM | GI | \infty]^r$ QUEUEING NETWORKS

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A queueing network of the $[SM | GI | \infty]^r$ type operates in the following way. From the outside a generic input flow arrives at the “ r ” nodes. The flow is controlled by a semi-Markov process $x(t) \in \{1, 2, \dots, N\}$ which is given by semi-Markov matrix $F(t) = \|F_{ij}(t)\|_1^N$. The arrival moments of calls coincide with the jump moments τ_n , $n = 1, 2, \dots$ of $x(t)$. If at time τ_n the process $x(t)$ passes to the state “ i ” then the call numbered “ n ” arrives to the node “ j ” with probability h_{ij} , $\sum_{j=1}^r h_{ij} = 1$. Each of “ r ” nodes is a multi-channel system to serve calls. If a call arrives in such system then its service begins immediately. The direction of call motion in the network interior is given by a switching matrix $P = \|p_{ij}\|_1^r$. For any $i = 1, 2, \dots, r$ $p_{ir+1} = 1 - \sum_{j=1}^r p_{ij}$ is the exit probability for the call served in the i -th node.

For this model it is considered a service process $Q(t) = (Q_1(t), \dots, Q_r(t))'$, $t \geq 0$, where $Q_j(t)$ is a number of calls in the j -th node at t moment of time. In the presentation for $Q(t)$ the conditions of stationary regime existence are pointed out. In heavy traffic a limit of the stationary distribution is found.

Note that the results develop investigations from [1].

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ON NORMALIZED DISTANCE BETWEEN SAMPLES AND ITS APPLICATION IN MEDICINE

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There are many live problems in medicine for now. Our purpose is to use a normalized distance between samples, which allows us to display the actual difference between two sets of data.

For example, that solves the problem of tracking the change in the "difference" between treated patients and healthy ones: with the flow of time this difference should become statistically insignificant if the treatment is efficient. One more purpose is choosing the most valuable factors among the set of ones: the most significant factors will have the largest normalized distance between sets of healthy and ill subjects.

One of the methods of resolving the problem was described in [1].

The purpose of the exploration was to obtain a probabilistic and integral distance. It was being constructed based on the distance of Mahalanobis and the assumption that this distance is Fisher–Snedecor distributed. Microsoft Visual Studio and SQL Server Express were used to develop an environment that allows to upload, store and get the data to run through the procedures and estimate required measurements.

Gemcitabine treated patients with metastatic pancreatic adenocarcinoma and low hENT1 expression were explored and it was discovered that with the flow of time the treatment was really efficient (normalized distance was getting lower).

On another hand it was discovered that the ferric concentration is increased even in the early stages of cancer and it increases with the progression of a disease and growth of tumor. So iron-excreting treatment could be used for cancer therapy.

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OPTIMALITY OF SIMPLE MORSE-SMALE FLOWS WITH SINGULARITIES ON THE BOUNDARY OF SURFACE

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Let M be a smooth surface with a boundary. We investigate the structure of flows on M with fixed points on the boundary.

Definition. A vector field X on a smooth manifold M with a boundary ∂M is called Morse-Smale vector field, if it satisfies the following conditions:

1) a set $\Omega(X)$ of nonwandering points X consists of a finite number of singularities and closed orbits and all of them are hyperbolic;

2) stable and unstable manifolds of two elements from $\Omega(X)$ cross transversally on $\text{Int } M$, but if a point from non-transversal crossing on boundary exists for two of these elements, then at least one of these elements is a singularity.

A flow that is induced by Morse-Smale vector field, we call Morse-Smale flow.

Morse-Smale flow on a surface with a boundary we call simple, if it doesn't have closed trajectories and all singularities lie on the boundary.

Simple Morse-Smale flow on a surface with a boundary is called optimal, if it has the least number of singularities among all simple Morse-Smale flows on this surface.

Theorem. [1] Simple Morse-Smale flow on a surface with a boundary is optimal, if and only if it has a single sink and a single source.

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A NOVEL METHOD FOR THE BILEVEL OPTIMIZATION PROBLEM¹

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Consider the problem of a bilevel composite minimization in finite-dimensional vector space

$$\begin{aligned} f_2(x) + g_2(x) &\rightarrow \min \\ \text{s.t. } x &\in \arg \min (f_1 + g_1), \end{aligned}$$

where f_1, f_2 – are convex smooth functions with Lipschitz-continuous gradients, g_1, g_2 – proper l.s.c. convex functions.

In this report, using the P. Tseng accelerated proximal-gradient scheme and Yu. Malitsky penalty trick, we develop a novel method for the bilevel composite optimization problem. The proposed algorithm generates sequences (x_n) , (y_n) , and (z_n) as:

$$z_n = \alpha_n x_n + (1 - \alpha_n) y_n,$$

$$x_{n+1} = \text{prox}_{(\lambda g_2 + \mu \alpha_n^{-1} g_1)} \left(x_n - \left(\lambda \nabla f_2(x_n) + \mu \alpha_n^{-1} \nabla f_1(z_n) \right) \right),$$

$$y_{n+1} = \alpha_n x_{n+1} + (1 - \alpha_n) y_n,$$

$$\alpha_{n+1} = \frac{\sqrt{\alpha_n^4 + 4\alpha_n^2} - \alpha_n^2}{2},$$

where $\lambda, \mu > 0$, $x_1 = y_1$, $\alpha_1 \in (0, 1]$.

We prove its convergence without the assumption of strong convexity. Several preliminary numerical experiments have been also performed to illustrate the convergence of the method.

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In conclusion we note that, in our opinion, the proposed algorithm is promising for the further investigation and can be used in practical applications.

ANALYSIS AND MODELING OF HOUSEHOLDS DEPOSIT DOLLARIZATION IN UKRAINE

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When we are looking into deposit dollarization. There is an objective reality (i.e. in countries with unstable economies and weak local currencies) where economic agents consider foreign currency to be a reliable asset worth of investing money in. Main reasons for deposit dollarization in emerging markets can be explained by hysteresis or ratchet effect due to high inflation, exchange rate volatility, interest rates volatility, money flow from abroad, currency competition in value storing etc. Thus, dollarization of deposits inevitably appears in banking systems of emerging markets. From the literature review, it becomes obvious that there are many factors that influence the decision of households to keep savings in one currency or another.

Thus, the goal of our study is to determine the significance of factors influencing the change in the level of household deposits dollarization (HDD) in Ukraine. Data for modeling are taken from the site of the National Bank of Ukraine and the State Statistics Service of Ukraine for the period from January 2006 to December 2017. Data are monthly.

We are also interesting in testing and analyzing structural change in econometric model for HDD. Two main classes of tests on structural changes are considered.

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COMPUTER-INTEGRATED SYSTEMS FOR INFORMATION SUPPORT AND AUTOMATIZATION OF THE COMPLICATED OBJECTS

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In the practical aspect, the urgency of the development and research of monitoring synchronous signals of information and telecommunication systems (ITS) and integrated power supply networks like SMART-technologies, for now is undoubtedly relevant [1-4].

The complex of software and hardware which was developed provides in automatic mode high-quality monitoring of synchronous signals by performing simultaneous multichannel measurements of the deviation of the time interval from the standard with subnanosecond accuracy. The results of the measurements are transmitted to the server of the computer-integrated system where they are processed using the software developed using the Microsoft Visual C++ P4000WinXP software.

Specialized server of the developed system based on the received data displays the results of measurements and builds real-time schedules for the deviation of the time interval of controlled syncsignals and provides for their fast view, recording to storage devices and operative access to data the staff of technical support.

Developed system provides direct, independent and reliable monitoring results of synchronization signals with centralized management and accumulation of data, which allows not only to locate and restrain the problems of form the synchronous to signal formation in a timely manner, as well as to use the statistical methods of information processing will predict the quality and stability of digital ITS and systems of power supply networks. Also it is envisaged to use the developed system for monitoring changes in time delay of transmission of syncsignals, which may be caused by a sharp increase of IP-networks load of as a result of cyber-attacks.

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SOLUTION OF CAUCHY PROBLEM FOR THIRD DISCRETE DERIVATIVE ADDITIVE-MULTIPLICATIVO-POVERATIVO DERIVATIVE EQUATION

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Let s look at the following equation:

$$\left(\left(y_n^{(I)} \right)^{[I]} \right)^{\{I\}} = f_n, \quad n \geq 0, \quad (1)$$

here $\{f_n\}, n \geq 0$ the giving sequence, $\{y_n\}, n \geq 0$ but it is the sequence of search.

Using the definition of the discrete additive, multiplicative and poverative derivatives, we obtain:

$$y_n^{(I)} = y_{n+1} - y_n,$$

$$\left(y_n^{(I)} \right)^{[I]} = (y_{n+1} - y_n)^{[I]} = \frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n},$$

$$\left(\left(y_n^{(I)} \right)^{[I]} \right)^{\{I\}} = \left(\frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n} \right)^{\{I\}} = \frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n} \sqrt{y_{n+3} - y_{n+2}}.$$

Then (1) will get the following form:

$$y_{n+3} = y_{n+2} + (y_{n+2} - y_{n+1}) f_n^{\frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n}}, \quad n \geq 0. \quad (2)$$

If we accept here: $n = 0$

$$y_3 = y_2 + (y_2 - y_1) f_0^{\frac{y_2 - y_1}{y_1 - y_0}}, \quad (3)$$

If we give $n = 1$ in expression (2), we receive:

$$y_4 = y_3 + (y_3 - y_2) f_1^{\frac{y_3 - y_2}{y_2 - y_1}}. \quad (4)$$

Cauchy problem:

Thereby how looks from (3) and (4), if

$$y_0 = \alpha_0, \quad y_1 = \alpha_1, \quad y_2 = \alpha_2. \quad (5)$$

We accept conditions, I mean for equation (1) if we look at Cauchy problem, we obtain:

$$y_3 = \alpha_2 + (\alpha_2 - \alpha_1) f_0^{\frac{\alpha_2 - \alpha_1}{\alpha_1 - \alpha_0}}, \quad (6_1)$$

$$y_4 = y_3 + (y_3 - \alpha_2) f_1^{\frac{y_3 - \alpha_2}{\alpha_2 - \alpha_1}}. \quad (6_2)$$

Here that is in this form y_3 (6₁). So we receive:

Theorem. If f_n , $n \geq 0$ the giving sequence, $\alpha_k, k = \overline{0, 2}$ as the giving constants $\alpha_0 \neq \alpha_1$, and $\alpha_1 \neq \alpha_2$ will be, then (1), (5) there is the unique solution of Cauchy problem and this solution gives trough by (2).

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PRIMARY DIAGNOSTIC INFORMATION SYSTEM OF CARDIOVASCULAR DISEASES BY ARTERIAL OSCYLOGRAPHY METHODS

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The implementation of modern ICT in health care practice makes it possible to improve prevention, diagnosis, early rehabilitation and treatment of cardiovascular system (CVS). According to the World Health Organization each year cardiovascular diseases (CVD) cause the death of 17.5 million persons; it is 31% of all deaths worldwide). High blood pressure is a major risk factor for heart attacks.

Arterial oscillogram obtained using monitor of blood pressure and heart rate, which records the value of pressure pulse changes in cuff when measuring blood pressure and export information through an external interface of data exchange to personal computer. Further analysis of the obtained data and creating of arterial oscillogram was conducted by computer programs developed by the authors. ICT of morphological, temporal, spectral, correlation and cluster analysis of oscillograms has been developed. An informative analysis of oscillograms criteria, criteria norms and averages and graded scales of deviations have been suggested. The studies, biological interpretation, methods of application and evaluation of the suggested methods are presented.

Unlike other, the suggested approach allows to get cheap, simple, rapid, objective, dynamic information during the procedure of blood pressure measurement. This primarily refers to the peripheral vessels state. Informational content and objectivity of the suggested technologies were approved by the detailed analysis of vessels of left and right shoulder, simultaneously registered electrocardio- and oscillogram; oscillograms recorded before and after exercise, massage and influence of others (26 kinds) factors.

Conclusions. Application of these ICT methods for arterial oscillogram analysis allows the physician expand information on: the

state of the autonomic nervous and cardiovascular systems and centralization level of their activities management; activity and interaction of various parts of nervous system, heart and brain rhythms. They increase the information content on functional reserves and body adaptive ability to resist external influences, mechanisms and quality process of homeostasis maintaining, speed and quality of recovery processes herewith, pathological process dynamics and effectiveness of rehabilitation methods application.

IMMUNOSENSOR MODEL BASED ON LATTICE DIFFERENCE EQUATIONS

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Although much progress on the predator-prey models with discrete or distributed delays has been made, such models are not sufficiently researched in the sense that most results are continuous versions related. Many authors have argued that the discrete models governed by difference equations are more appropriate than the continuous time ones when populations have a short life expectancy, nonoverlapping generations in real world.

We consider the delayed antibody-antigen competition model for biopixels two-dimensional array

$$V_{i,j}(n+1) = V_{i,j}(n) \exp\{\beta - \gamma F_{i,j}(n-r) - \delta_v V_{i,j}(n-r)\} + \hat{S}\{V_{i,j}(n)\},$$

$$F_{i,j}(n+1) = F_{i,j}(n) \exp\{-\mu_f + \eta \gamma V_{i,j}(n-r) - \delta_f F_{i,j}(n)\}, n, r \in \mathbb{Z} +.$$

Here $V_{ij}(t)$ is the concentration of antigens, $F_{ij}(t)$ is the concentration of antibodies in biopixel (i, j) ; $i, j = \overline{1, N}$.

$$\hat{S}\{V_{i,j}(n)\} = D\{V_{i-1,j}(n) + V_{i+1,j}(n) + V_{i,j-1}(n) + V_{i,j+1}(n) - 4V_{i,j}(n)\}$$

is spatial diffusion-like operator. Stability research uses approach of Lyapunov functions. Numerical simulations are used in order to investigate qualitative behavior when changing the value of time delay $r \in \mathbb{Z} +$.

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A PROBLEM WITH A TYPE-2 FUZZY GOAL SET

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Bellman-Zadeh approach [1] to solving a problem with fuzzy defined goal is that the goal of decision making and the set of feasible alternatives are considered as equitable fuzzy sets of some universal set of alternatives. This makes it possible to fairly simply determine the solution.

In this paper, the Bellman-Zadeh approach is applied to the decision-making problem, which is defined on type-2 fuzzy sets (T2FSs). T2FS Solution is defined. An extension of the natural order ratio to the class of fuzzy sets is used for comparison of fuzzy sets of alternatives membership degrees [2].

It is shown that this is a fuzzy preference relation provided that fuzzy sets of membership degrees of a solution T2FS are normal. A fuzzy set of non-dominated alternatives is constructed by this preference relation. The notion of the α -level non-dominated alternative is introduced. It is shown that this is optimization problem solution. In this problem the primary membership degree of a solution T2FS is maximized with a limited secondary degree. The question of the existence of 1-level non-dominated alternatives is investigated. It is clarified that when choosing a maximizing alternative one should be guided by the requirement to get as large values as possible both a primary membership degree to the solution T2FS and a secondary grade. The alternatives choosing problem by two criteria (the primary and secondary degrees of membership to the solution T2FS) is formulated. Its Pareto optimal solutions are called effective maximizing alternatives. Their properties are investigated.

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MULTILEVEL ACCESS TO INFORMATION SYSTEMS USING QR CODES

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The QR code (the word QR code is the Quick Response Code encoding, which means a quick feedback code) is an innovative technology, a two-dimensional code that stores data. It keeps information about some of the products just like the normal barcode and the same can be said on the QR-code.

Although the QR code was created for manufacturing purposes, it has become a very essential attribute in the advertising industry, which has been promoting the so-called " The massive spread of smartphones, since any smartphone owner can bar the bar code reader in his own pocket. Human imagination is infinite and began to create very original and creative use of QR codes in different countries, such as a supermarket set up in South Korea, which is built on the QR code system.

Static codes consist of useful information. This means that it is impossible to track and change information. This is very uncomfortable because if you need to change the information you need to print out the previously printed materials. Dynamic codes consist of links to a specialized web server that creates information about what information to display, or which link to redirect. This means you can keep track of a dynamic code (collecting static information) and that it may be possible to change the destination bar or edit it without interfering with the source code.

Since the dynamic codes are quite expensive, there are some ways to create multilevel access mechanisms through static QR codes, besides the main link in the static QR code, the addition of the level of access level is added. The information system will read what this article is about, analyzes the link and adds an account, analyzes the level of access to the authorized user and transmits it to the information that he / she has.

The advantage of this approach lies in its simplicity and has more functionality than dynamic codes. It is available on any device with a QR code reader and Internet connection.

MANAGEMENT DECISION-MAKING IN THE CITY'S BUDGET FORMATION PROCESS

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One of the priority tasks of the state financial policy is to create the complex, sustainable, most multi-purpose and troubled unit of the city's socio-economic development – the creation of flexible budget system. This priority is due to the fact that the main economic and financial relations are established at the level of cities, with both local and foreign entrepreneurs, businessmen, bankers, investors, etc.

The mechanisms for formation and expenditure of local budget are strengthened by the Constitution of Georgia. It is a fundamental basis for financial interdependence of local and government institutions that is protected with the principles of state guarantee and provides financial, economic and organizational independence.

The sustainability of the financial system of the city is directly dependent on the quality of local budget formation and expenditure processes. Therefore, the level of efficiency of the formation and expenditure mechanisms of the local budget requires the building of the united system for budgeting process management. The united system for budget process management will contribute to the formation of the budget, and then to the creation and implementation of effective decision-making algorithms in the expenditure process.

As we can see, the budgeting process is a difficult, responsible and problematic part of the city's socio-economic development.

One of the main problems in budgeting is to predict the financial situation, resources, revenues, costs and other additional aspects. In this aspect, it is necessary to make the right decisions. Indeed, any action on how the financial position of the city will be assessed, the budget audit and the performance of the budgetary firms are based on the forecasting data. As we know, forecasting is conducted from the statistical analysis, where the data is taken from the past period, and due to the peculiarity of the budget formation, often decisions based on these data may not be effective.

The result of the decision making process in the formation of the budget should be the creation of the information system that contributes to show all financial information, cash, financial resources, enterprise accounts and assets, etc. in an appropriate way.

In the report, there are discussed:

- The procedure of the city's budget formation, which is used in the budget formation process and covers information at all level, received from both internal and external sources, and provides the effective decision-making within the competency;
- The potentials of the city's capabilities, as the main function of budget formation;
- The task of budget formation forecasting and evaluation;
- Cost of budget expenditure.

DECISION SUPPORT SYSTEM FOR THE ANALYSIS OF INFORMATION INFLUENCE IN SOCIAL NETWORKS

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The development of modern information technologies has led to the emergence of new directions for their application. Among them, an important place is occupied by information-impact technologies with the aim of achieving certain political, economic and military goals. An important role in these processes is played by social networks [1]. They provide a convenient means of communication between people, ensure the supply of information and impact on network participants, forming a social thought.

When analyzing and forecasting the development of social situations, preparing options and results of information impact, special attention should be paid to obtaining data from social networks, modeling and researching the interaction between its various participants, creating methods of supporting decision-making of information-psychological nature. The amount of information received from social networks is too large to quickly view and process constantly updated data streams. At the same time, most of this information is non-essential, without providing content that is meaningful for analysis. To select the necessary data from large volumes of heterogeneous information and their further use for assessing the nature of the possible impact and ways of disseminating information flows in a social network, it is necessary to carry out a comprehensive work package. It includes: determining the composition of indicators and selection criteria, assessing the reliability

of data, analyzing social communities, analyzing group members, analyzing deviations (the dynamics of processes), determining the goals and content of the solution, and developing options for possible solutions, taking into account the results of modeling and forecasting the development of events.

Based on the problems and tasks of researching information impact in social networks, it is proposed to create a decision support system, the application of which will allow improving technological solutions for the design of information security tools and methods of information confrontation, taking into account the importance of solving problems in the modern information space of the country.

The process of creating DSS for the analysis of information influence in social networks provides

- development of models and methods for studying the processes of dissemination and influence of information in social networks, within the framework of which it is planned to create new mathematical models and methods for analyzing information distribution and influence; modeling operational and strategic results of information impact; verification of models of social spread and influence of information.

- formation of a database and knowledge for sources of information impact, their analysis, classification and clustering. For this purpose, it is planned to classify information flows and used the factor analysis of information sources and processes; to develop the new methods and algorithms for building social communities; to applicat the new approaches in the tasks of grouping social graphs; to develop the approaches for processing large amounts of information.

- implementation of components of the software subsystem of DSS in the form of information processing modules; modules of simulation modeling of penetration processes, distribution and influence of information; modules of forecasting about the influence of information flows and the prototype of the interface part of DSS for the tasks of analyzing information flows.

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ESTIMATION OF INFLUENCE FOR MODELS OF INFORMATION SPREADING PROCESS UNDER UNCERTAINTY

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Let there be a certain social community of L people, potentially subject two information flows [1-4]. Functions $x_1(t)$ and $x_2(t), t \in (0, T)$ are the time t -depended number of people, who have accepted one of the information flows. Information is spread in the community along internal (interpersonal communication of the member of social community) and external threads (mass media).

Let us denote by $x_1(t) \in R^1$ and $x_2(t) \in R^1, t \in (0, T)$ the solutions of differential equations:

$$\begin{cases} \dot{x}_1(t) = a_1(t)x_1(t)(L - x_1(t) - x_2(t)) + u_1(t), \\ \dot{x}_2(t) = a_2(t)x_2(t)(L - x_1(t) - x_2(t)) + u_2(t), \end{cases}$$

where $a_1(t)$ and $a_2(t)$ – are the known functions of interpersonal communication; $u_1(t)$ and $u_2(t)$ – are the parameters of external influence.

Consider the case where $x_2(t), t \in (0, T)$ and $u_2(t), t \in (0, T)$ are known. Denote the observed vectors $y_k, k = \overline{1, N}$:

$$y_k = x_1(t_k) + v_k, k = \overline{1, N}, 0 < t_1 < \dots < t_N \leq T,$$

where $v_k, k = \overline{1, N}$ – the observed errors, $((y_1 - x_1(t_1), \dots, y_N - x_1(t_N)), u_1(t)) \in V \subset R^N \times L_2(0, T)$.

Let us denote a posteriori set G :

$$G = \left\{ u_1 : I(u_1) = \sum_{k=1}^N q_{1k}^2 (y_k - x_1(t_k))^2 + \int_0^T q_2^2(t) u_1(t) dt \leq \gamma_1^2(T) \right\},$$

where $q_{1k}^2, k = \overline{1, N}, \gamma_1^2(T)$ are known numbers, $q_2^2(t)$ is known function.

Definition. The optimal estimation of influence $u_1(t), t \in (0, T)$ is said $\hat{u}_1(t), t \in (0, T)$, which satisfies the condition

$$\hat{u}_1 \in \underset{u_1 \in G}{\operatorname{Arg\,min}} I(u_1).$$

We apply the numeric algorithm of estimation of influence $u_1(t), t \in (0, T)$.

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NOTES ON DYNAMIC PANEL DATA ANALYSIS IN TERMS OF MODELING DETERMINANTS OF MILITARY SPENDING

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The contribution deals with the problem of dynamic panel data modeling. One can find several methods of estimation dynamic data model parameters. We focus on two commonly used approaches. One is based on a generalized method of moments [1], the second employs a pooled mean estimator in autoregressive distributed lag (ARDL) models [3]. Properties of mentioned estimates are discussed. The models are applied to time series of military spending in selected NATO member countries and to other time series describing the economic and security environment in analyzed states in order to identify possible determinants of military spending.

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PROPERTIES OF LOGICS OF GENERAL NON-DETERMINISTIC QUASIARY PREDICATES

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In this report we study new classes of program-oriented logical formalisms: composition-nominative logics of general non-deterministic quasiary predicates which we call *GND*-predicates. These logics reflect such properties of programs as partiality, nondeterminism, and non-fixed arity. *GND*-predicates are a generalization of already studied partial non-deterministic relational predicates – *R*-predicates. Each *R*-predicate is specified by two sets: the truth and the falsity domains. To describe a *GND*-predicate one more set is needed: truth, falsity, and underfinedness domains. For these predicates, such important laws of traditional logic as the absorption law and the distributive law for $\vee$ and $\&$ are not valid. Various types of *GND*-predicates are defined [1], including single-valued *GND*-predicates – *SG*-predicates.

GND-predicates can be modeled as 7-valued total deterministic predicates (*TD7*-predicates). A 7-element algebra of truth values of *TD7*-predicates is defined and all of its subalgebras are described. Each subalgebra induces a corresponding algebra of *TD7*-predicates, which in its turn induces an algebra of *GND*-predicates. This makes possible to identify a number of composition algebras of *GND*-predicates. Algebra of *R*-predicates is not a subalgebra of algebra of *GND*-predicates, however, it is an embedding in algebra of *GND*-predicates.

Languages of pure first-order logics of *GND*-predicates and their interpretations are described. We define relations of logical *G*-consequence, *SG*-consequence, *G*-equivalence, *SG*-equivalence. Relations of logical *G*-consequence $|\models_G$ and *SG*-consequence $|\models^{SG}_G$ for sets of formulas are studied. For the latter relations, properties of decomposition of formulas and of quantifier elimination are described. We specify conditions which guarantee an existence of $|\models_G$ and $|\models^{SG}_G$. Properties of these relations are identical to the corresponding properties of relations $|\models_{TF}$ and $|\models^p_{TF}$ of logics of *R*-predicates. On the basis of these properties, we propose calculi of sequent type for logics of *GND*-predicates.

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ANALYSIS OF THE MATHEMATICAL MODEL OF INFORMATION WITH EXTERNAL IMPULSE INFLUENCE

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With the technological development of society, the possibility of information influence on social communities becomes increasingly important. From the end of the twentieth century, a number of leading scholars from different countries consider the dissemination of information as one of the leading roles in the internal and external socio-economic processes. There were publications that describe the process of disseminating information, the possibility of using it in their own interests, both for the dissemination of "necessary" information and for counteracting unwanted tendencies in society. An extremely important issue that has arisen for this area is the construction and systematic analysis of mathematical models that adequately describe this process. The perspective direction for this problem is mathematical models written in the form of stochastic evolution equations with impulse influence

$$dL^\varepsilon(t) = C(L^\varepsilon(t), x(t / \varepsilon^2))dt + d\eta^\varepsilon(t), \quad (1)$$

where $x(t)$ is an uniformly ergodic Markov process in a standard phase space $(X, \mathbf{X})$, defined by generator

$$\mathbf{Q}\varphi(x) = q(x) \int_{\mathbf{X}} P(x, dy) [\varphi(y) - \varphi(x)],$$

$$C(L, x) = \alpha_1(x)L_0(x) + \alpha_2(x)L_0(x)L(t) - \alpha_2(x)L^2(t)$$

$$C(L, x) = \alpha_1(x)L_0(x) + \alpha_2(x)L_0(x)L(t) - \alpha_2(x)L^2(t)$$

$$\alpha_1(x) = \alpha_{11}(x)\alpha_{12}(x) \quad \text{- external channel;}$$

$$\alpha_2(x) = \alpha_{21}(x)\alpha_{22}(x) \quad \text{- internal channel;}$$

$L(t)$ - the number of "recruited" adherents;

$L_0(x) - L(t)$ - the number of not yet "recruited" adherents;

$\eta^\varepsilon(t)$ simulates impulse effects, which can be, for example, new information channels appearing on the community;

We study the behavior of similar social systems that are exposed to information influences. It is clear that there will be fluctuations. We will also see if the system is close to the average. This approach should be used to construct and systematic analysis of more general models of information struggle, as well as to develop algorithms for finding predicted validation estimates for this model with incomplete observations.

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MODELLING OF COMPLEX HIERARCHICAL SYSTEMS ON THE BASIS OF FUZZY COGNITIVE MAPS

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Modelling of complex hierarchical systems is based on mathematical support simultaneous use of methodologies foresight and cognitive modeling as follows: at the first stage, apply the methodology of foresight and use the results as input data in the second stage — for cognitive modeling. Such synthesis of methodologies allows proposing a scientifically grounded strategy for implementing of scenario for priority alternative of the various complex systems. In the process of studying complex systems various hierarchical cognitive models can be developed, as well as models of cognitive models interaction [1, 2]

$$I_G = \langle G_k, G_{k+1}, E_k \rangle, k \geq 2,$$

where I_G is hierarchical cognitive map, G_k and G_{k+1} are cognitive maps of k and $k+1$ levels, some vertices of which are connected by arcs E_k

The matrix of relations A_{ω_G} is a fuzzy square matrix whose rows and columns are labeled with vertices of graph G , and at the intersection of the i -th row, j -th column there is a function of membership of the fuzzy value, which represents the expert's judgment of the relationship between vertices, if there is a relation between the elements V_i and V_j , that is

$$A_{\omega_G} = [\omega_{ij(G)}], \omega_{ij} = \omega_{ij} \langle v_i, v_j \rangle (f) : [-1; 1] \rightarrow [0; 1]; i, j = \overline{1, n}$$

The study uses the representation of a linguistic variable corresponding to each of the concepts of a cognitive map, in the form of a set of terms; the membership function for each is constructed by approximating the discrete values obtained by one of the standard curves.

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THE STATISTICAL SIMULATION OF THE SELF-SIMILAR TRAFFIC

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In the article methods of statistical modeling of fractional Brownian motion (FBM) for modifying the self-similar traffic are used. The estimation of probabilities of buffer overflow based on the properties of FBM is found.

A number foreign scientists are actively engaged in the area of analysis and simulation of self-similar traffic. Work in this direction should be noted [1-5], as well as work [4-5].

Let's $A(t)$ is the amount of traffic that enters the network in the time interval $[0, T]$, Let us specify that $A(s, t) = A(t) - A(s)$, $t > s > 0$. According to [1] incoming traffic has the form $A(t) = mt + \sqrt{am}W_\alpha(t)$ where m is the average traffic intensity, $W_\alpha(t)$ is the fractional Brownian motion with the Hurst index, $\alpha \in \left(\frac{1}{2}, 1\right)$, a is a constant.

If the network has one device with a service speed $C > m$, then the loading process is determined [12] by the formula $Q(t) \equiv \sup_{s \leq t} (A(s, t) - C(t - s))$. In the presence of n independent equivalent

devices we will have $Q_n(t) \equiv \sup_{s \leq t} \left(\sum_{i=1}^n A_i(s, t) - nC(t - s) \right)$. The badge

$\equiv$ means the equality of distributions.

We will investigate on the segment $[0, T]$ the estimation of the probability that the value of the load $Q(t)$ exceeds a certain threshold b (the probability of overflow). Let us denote $Q \equiv \sup_{t \in [0, T]} (Q(t))$,

$\pi(b) = P\{Q \geq b\}$.

For the probability of overflow, we find upper bounds

$$P\{Q \geq b\} \leq P\left\{\sup_{t \in [0, T]} (Q(t)) > b\right\}.$$

$$\text{Therefore } P\{Q \geq b\} \leq P\left\{\sup_{t \in [0, T]} (|W_\alpha(t)|) > \frac{b + T(C - m)}{2\sqrt{am}}\right\}.$$

For $\varepsilon_b = 0.05$, $C = 100$, $m = 96$, $a = 1$, $T = 1$ i $\alpha = 0.8$ the threshold should be $b \geq 310$.

Methods of statistical simulation of fractional Brownian motion were developed. The methods are based on the spectral representation of random processes and use the property that the FBM has stationary increments. The indicated methods are used for simulation of the same traffic and loading process of telecommunication networks. Estimates of probability of overflow found.

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ONOPTIMIZATION OF $M/M/c$ QUEUE WITH THE LIMITED NUMBER OF RETRIALS AND CONSTANT RETRIAL RATE

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Retrial queues are characterized by that a primary customer who finds busy the service facility upon arrival moment immediately leaves the servers area, but some time later he repeats his demand. Between retrials he is said to be in 'orbit' [1]. Retrial queues have been widely used to model the many practical situations arising in telephone systems, telecommunication networks, wireless networks and call centers.

In this paper, we consider controlled multi-channel queueing system with a single retrial attempt to begin service process and constant retrial rate. Such system is determined by next parameters: λ_j is the arrival rate that depends on the number of sources of repeated attempt, μ is the service rate and ν is the rate of repeated attempt.

The system with a single retrial attempt at time t are modelled by a two-dimensional Markov chain $Q(t) = (Q_0(t), Q_1(t))^T, t \geq 0$ with continuous time in phase space $S = \{0, 1, \dots, c\} \times Z_+$. The component $Q_0(t)$ is the number of busy servers at time t , $Q_1(t)$ is the number of sources of repeated attempt at time t .

For this system we consider situation when the rate of input flow is controlled by the threshold strategy. That is, if in some moment of time the total number of customers in the orbit of the system does not exceed the value H then the system operates in the first mode with the rate of input flow h_1 . If it is more than H then the system switches the second mode with the rate of input flow h_2 . In accordance with this strategy, the multi-criterion optimization problem of the effective functioning of the system is formulated and solved. Quality functionals of the optimization problem are represented through the stationary probabilities.

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THRESHOLD METHODS FOR SIGNAL COMPRESSION

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The present work is closely connected to the real problem, arising up at the signal processing in the cellular telephone systems, because of the background noises in them. When a vocal signal is transferred from a cellular telephone to the base station or in other direction, it should be compressed in order for an operator could transfer as many signals as the real carrying capacity of the channel can allow.



Fig.1 Functional characteristics of supersonic thresholding:
 a - linear, b - quadratic

Threshold methods of noise decrease are based on diminishing of coefficients values of signal transformation while its transfer from one representative domain to another (time-frequency, time-space, and other). It is assumed that the noise component is represented by small coefficients and the threshold method is used for reduction or complete removal of small coefficients. Then the signal is exposed to reverse transformation.

Soft and hard thresholds are most often used. As it is assumed that the algorithm of processing should operate in a real-time mode, and the length of input signal can be large so the input signal is divided into small segments (shots). The algorithm of processing is used on each segment and the output result is represented as a composition of separate processed segments. Processing of separate segment requires time that all in all leads to the delay of signal in communication network. Let's designate the size of the threshold θ . We will try to modify the functional characteristic (FC) so that to provide the least distortions of the restored signal. The simplest decision for this task is realization of FC of threshold types, shown on Fig. 1. We will name them FC of linear

supersoft thresholding (Fig. 1,a) and FC of quadratic supersoft thresholding (Fig. 1,b).

MODELLING CUSTOMER BEHAVIOUR IN ONLINE GAMBLING

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In this paper a continuous Markov chain is constructed to model the behavior of gaming customers while they engage online alternating between periods of inactivity and high intensity interaction. An extensive database containing daily transactions provided by a major operator was analyzed statistically. Using various clustering methods a suitable state-space capturing the categorization of customers was defined. This enabled Markov chain models to be fully specified for various categories of customers. Corresponding transitions probabilities and survival times were estimated.

VIABLE POSTERIOIRS FOR LÉVY PRIORS

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Nonparametric Bayesian statistics is a mathematically very demanding discipline. It requires stables of docile prior probability distributions having large support with resulting posteriors which are tractable preferably analytically, but at the very least computationally. This wish-list has been gradually addressed and in many ways fulfilled. Stochastic processes had come to the rescue in the early 70's. Firstly it was Dirichlet processes which provided large families of measures with acceptable mathematical tractability while MCMC has supplied sufficient computational prowess for Bayesians to launch reasonably successful modelling attempts back by acceptable mathematical theory. But, they also have their limitations which impinge on the scope of their applicability. Measures derived from Lévy processes were put into to good use in the spirit of generalization to feed the needs for more flexible priors. In effect the theory of completely random measures offers a theoretically superior context which is more inclusive than all

the others and bases itself on Poisson process constructs. In this paper various properties and results from the theory of Lévy processes will be entertained with reference to the problem of providing priors able to generating posterior probabilities which can be calculated and effectively simulated by suitable algorithms.

THE MULTIDIMENSIONAL STATISTICAL ANALYSIS OF INSURABLE VALUE ASSESSMENT PROCESS

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The main objective of this article is to determine a property insurable value by the means of multidimensional classification methods. A real database consisting of family houses in the Czech Republic was used to find out the prediction abilities of variables used in relevant models. The methodology is based on classification and regression trees created by the CHAID, CART and QUEST algorithms, and also by a multivariate linear regression. After the tree is created, the input variables which contributed to the classification are used in the regression model. The obtained outcomes illustrated a high degree of statistical association of selected predictors with the estimated insurable value of property, as well as with a relatively low percentage of misclassified objects. The designed methodology may be applied in other areas as well, for example in decision-making processes.

DECISION MAKING USING MATHEMATICAL MODELS BASED ON LABELED GRAPHS

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We consider finite undirected graphs that do not have multiple edges and loops, as a model of the system. Under the labeling f of the graph $G = (V, E)$ we mean an injective or bijective labeling of its elements into a given numerical set $X \subset \mathbb{Z}$ (or $X \subset \mathbb{N}$), satisfying certain conditions. The set of labels $X^* \subseteq X$ of the elements of graph G is a collection of discrete objects. Therefore, X^* can be considered as some

combinatorial configuration, between the elements of which certain relations are established with the help of a given set of requirements (axioms). Thus, the task of constructing a graph labeling is the task of constructing combinatorial configuration under given constraints. Moreover, the well-known theorems of the theory of labeling [1] allow one to answer the question of the existence of a corresponding configuration.

In this paper, we study problems that when being solved use mathematical models based on labeled graphs. These include the following:

Task 1. Designing a system of mobile devices with self-organization.

Task 2. Optimization of the process of IP packet transmission in MPLS networks.

Task 3. The task of planning with the properties of an incomplete circular tournament.

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MULTICRITERIA COMBINATORIAL OPTIMIZATION PROBLEMS WITH INEXACT DATA OF OBJECTIVES

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Multicriteria problems emerge if one needs to optimize more than single objective function. It is interesting to consider the latter problems as the ones of combinatorial optimization under uncertainty. Applying classical optimization methods to real problems does not always yield the desired result. Two of the main difficulties are that often various conflicting objectives are relevant for the same problem and that not all parameters of a model can be predicted accurately in advance. A review of recent results in combinatorial optimization problems under uncertainty of data is presented. It is known that the convex hull of set of permutations is the polyhedron of permutations, in which the set of vertices is equal to set of permutations. Such a permutations polyhedron property allows to reduce a solution of initial problem to a problem solution on a continuous feasible set [1]. Consider the multicriteria

problem defined on the combinatorial set of permutations which is submerged in the arithmetic Euclidean space, and the problem has the following form: $Z(C, X): \max\{Cx \mid x \in X\}$, where Cx is the linear vector criterion, $Cx = (\langle c_1, x \rangle, \dots, \langle c_\ell, x \rangle)$, $X = \Pi \cap D$, $\Pi = \text{conv } P(A)$, $D \subset R^n$, $x \in R^n$, $c_i \in U_i \subset R^{k_i \times n}$, $i \in \{1, \dots, \ell\}$, U_i are subsets, expressing inexactness of the data. Various approaches to this problem have been developed in the past with different descriptions of changes in the input data [2]. The solution of the problem is understood as searching for the elements from one of the following sets: of the Pareto-optimal solutions, of the Slater-optimal solutions, of the Smale-optimal solutions. The different representations of principles of optimality under uncertainty are discussed. Various robust concepts are presented, namely the traditional minmax approach with some of its recent extensions, and several two-stage algorithms. A special attention is spared to the computational properties of the problems considered.

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PROPERTIES OF SETS SOLUTIONS OF QUASI CONVEX PROBLEMS OF LEXIGRAPHICALLY LEXICOGRAPHIC OPTIMIZATION

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The problems of multicriteria optimizations are examined in which the orders of criteria of preference are represented as a convolution of convolutions.

Let $F(x) = (f_1(x), \dots, f_l(x))$ – a composite convolution of the criteria $f_k(x) = (f_{k1}(x), \dots, f_{kd_k}(x))$, $k = 1, 2, \dots, l$, according to the subordination of strict arrangement [1], each of which is a vector

convolution of strictly arranged quasi convex functions of the criteria $f_{ki}(x)$, $i=1,2,...,l_k$. The problem of lexicographically lexicographic maximization is being investigated

$$\max^L \{F(x) | x \in X\}, \quad (1)$$

where $X \subset R^n$ – is a bounded feasible set being described as a certain finite system of linear equations and inequalities. Let $Z(F(x)) = (f_{11}, f_{12}, ..., f_{1l_1}, ..., f_{l1}, f_{l2}, ..., f_{ll_l})$. We will solve the problem

$$\max^L \{Z(F(x)) | x \in X\}. \quad (2)$$

Let's indicate $LL(F, X)$ and $L(F, X)$ the sets of the optimal solutions of the problems (1) and (2) correspondingly, $P(F, X)$ is the set of the Pareto-optimal solutions of the problem (2). [1, 2].

Theorem 1. Problems (1) and (2) are equivalent.

Corrolary 1. $LL(F, X) \neq \emptyset$.

Coorrolary 2. $LL(F, X) \subset P(F, X)$.

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TWO-SIDED APPROXIMATION FINDING OF A FUNCTION BASED ON MATHEMATICS OF FUNCTIONAL INTERVALS

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Let the function $y(x)$ be twice continuously differentiable over the interval $[a, b]$ and at this interval

$$\underline{k} \leq y''(x) \leq \bar{k}, \quad (1)$$

where $\underline{k}, \bar{k}$ are some constants; y_a, y_b, y'_a, y'_b are the value of the function $y(x)$ and its first derivative at the ends of the interval $[a, b]$, respectively;

$$\overline{p1}_a(x) = 0.5 \bar{k} x^2 + (y'_a - \bar{k} a) x + 0.5 \bar{k} a^2 - y'_a a + y_a, \quad (2)$$

$$\underline{p1}_a(x) = 0.5 \underline{k} x^2 + (y'_a - \underline{k} a) x + 0.5 \underline{k} a^2 - y'_a a + y_a, \quad (3)$$

$$\overline{p2}_a(x) = 0.5 \underline{k} x^2 + (y'_b - \underline{k} b) x - 0.5 \underline{k} a^2 - (y'_b - \underline{k} b) a + y_a, \quad (4)$$

$$\underline{p2}_a(x) = 0.5 \bar{k} x^2 + (y'_b - \bar{k} b) x - 0.5 \bar{k} a^2 - (y'_b - \bar{k} b) a + y_a; \quad (5)$$

On the basis of the mathematics of function intervals [1], it is proved that then

$$y_b \in [c_1, d_1] \cap [c_2, d_2], \quad (6)$$

where the constants c_1, d_1, c_2, d_2 are determined in an appropriate way through the values of the polynomials (2) - (5) at the end of the interval $[a, b]$.

This makes it possible to concretise and generalize the theorem on the average function $y(x)$ and its derivative.

Thus, we obtain essentially narrower two-sided approximations of solutions of the Cauchy problem [2] and boundary problems.

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APPROACHES TO OPTIMIZE INVESTMENT RISKS

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Dynamic development of market relations stipulates a necessity to the enterprises of improvement of investment attractiveness the increase of that can be attained due to the decline of investment risks.

The change of investor aims and investment resources volumes, considerable vibrations of the affairs state investment market, change of percents rates, expansion of financial suggestions investing instruments and row of other terms, cause the necessity of investment risks currents.

Concordantly to the theory management investment risks two fundamental going is distinguished near optimization of investment risks – it active and passive. These approaches differentiate both tasks and methods of operative management investment risks.

The active going near a management investment risks can be used on principle of «market passing». Practical realization of this approach means that restructuring of briefcase investments financials must be based on prognosis calculations of the affairs market states, and to remove her current dynamics. For this, approach the characteristic individualized estimation of future market value of investing financial instruments.

The passive going near a management investment risks can be used on principle of «passing in the waterway of market». Practical realization of this approach means that restructuring go briefcase of financial investments must clearly remove the tendencies of the affairs states of fund market. Basic attention at the passive going near a management is spared to providing of briefcase restructuring on the types of financial instruments with the aim of decline risk investments.

Thus, active and passive approaches enterprise investment risks optimizations are enough difficult processes for realization. Complication of management the enterprises investment risks determines the necessity of deployment for this process of modern computer technologies.

Programmatic instruments that is constrained with the use of such technologies must provide monitoring of basic parameters of separate financial instruments and making of timely administrative decisions.

GAUSS-NEWTON-POTRAMETHOD FOR NONLINEARLEAST SQUARES PROBLEMS WITH OPERATOR DECOMPOSITION

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Consider the nonlinear least squares problem

$$\min_{x \in R^p} \frac{1}{2} (F(x) + G(x))^T (F(x) + G(x)), \quad (1)$$

where residual function $F + G : R^p \rightarrow R^m$ ($m \geq p$) is nonlinear by x , F is a continuously differentiable function, G is a continuous function, differentiability of which, in general, is not required.

In this work, we propose the method for solving nonlinear least squares problem with a non-smooth operator (1), based on the Gauss-Newton and the Potra methods [1]

$$x_{k+1} = x_k - (A_k^T A_k)^{-1} A_k^T (F(x_k) + G(x_k)), \quad k = 0, 1, 2, \dots, \quad (2)$$
$$A_k = F'(x_k) + G(x_k, x_{k-1}) + G(x_{k-2}, x_k) - G(x_{k-2}, x_{k-1}),$$

where $F'(x_k)$ is Frechet derivative of at x_k , $G(x_{k-2}, x_k)$, $G(x_{k-2}, x_{k-1})$ are first order divided differences of function at appropriate points; x_0 , x_{-1} , x_{-2} are given initial approximations. Local convergence of the method (2) was proved. Its efficiency has been demonstrated on the test problems in comparison with other method for given class of problems.

Note that in the case $m = p$ method (2) is identical to method, investigated in the paper [2].

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SOME METHODS FOR SOLVING NONLINEAR LEAST SQUARES PROBLEMS

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Nonlinear least squares problems often arise while solving of overdetermined systems of nonlinear equations, parameter estimation of physical processes by measurement results, constructing nonlinear regression models for solving engineering problems and more. The most used methods for solving nonlinear least squares problems is Gauss-Newton's method [1] and methods with divided differences [2].

Consider the nonlinear least squares problem with function that has differentiable and nondifferentiable parts

$$\min_{x \in R^p} \frac{1}{2} (F(x) + G(x))^T (F(x) + G(x)). \quad (1)$$

Here residual function $F + G : R^p \rightarrow R^m$ ($m \geq p$) is nonlinear by x , F is a continuously differentiable function, G is a continuous function, differentiability of which, in general, is not required.

For solving such problems we can apply difference methods [2], but more effective are methods that use a sum of the derivative of differentiable part and the divided difference of nondifferentiable part of the operator instead of the Jacobian. In the article [3] we propose Gauss-Newton-Secant method and studied local convergence under Lipschitz condition. In this work we investigate local convergence of the Gauss-Newton-Secant and Gauss-Newton-Kurchatov methods and uniqueness of solution of equation (1) under weak ω -type conditions. In this case we don't suppose the existence of the operator $G'(x^*) = G(x^*, x^*)$. On several test problems we compare convergence rates of combined methods and basic methods.

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UNCERTAINTY CONDITIONS AND TIME DELAY IN LANCHESTER'S COMBAT MODELS

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F. W. Lanchester originally published his mathematical model for air to air combat [1,2]. There are three main types of such systems: “direct fire” model, model “guerilla warfare” and so-called “mix warfare” model. These models known as the linear and square law became the basis for much of the analysis of combat. These differential equations models have been the methodology to present and solve many historical combat models. All these models are well studied in the continuous case.

In the end of XX many scientists alluded to difficulties in solving more difficult “realistic” equations and suggested numerical methods that can easily and conveniently be numerically solved on a computer. The use of computers to analytically solve or numerically solve combat models is the standard method. Discrete dynamical system (difference equations) as the discrete form of Lanchester's equations in combat models start to use and study at the beginning of XXI [3]. Some works in this direction were conducted in TSNUK, Kyiv, Ukraine as the bachelor's theses in 2015, 2016.

This report is a continuation of the research [4] and devoted to new problem in such kind models, namely:

- the presence delay in the equations when we have case of belated reaction of one of the sides of the battle
- the presence of interval uncertainty in coefficients of the models.

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PROPER ORTHOGONAL DECOMPOSITION FOR ORDINARY DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS

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Proper orthogonal decomposition (POD), also known as Karhunen–Loeve decomposition or principal component analysis, provides a technique for reducing the dimensionality of a given dataset of the considered system by representing it onto an orthonormal basis which is optimal in a least-squares sense [1].

In this paper, we apply POD for the systems that are modelled by ordinary differential equations (ODEs) and by partial differential equations (PDEs). The approximation achieved with POD refers only to a discrete number of system responses that are already computed in the set of snapshots using the high-fidelity model. In order to make a continuous approximation of the system over certain domain of input parameter the POD is combined with radial basis functions (RBFs).

POD-RBF procedure can be summarized as follows: choose sampling strategy and define sampling matrix of input parameters over some domain in parameter space; compute a snapshot matrix by solving the high-fidelity approximation of problem in sample points; perform POD by using the singular value decomposition (SVD) of the snapshot matrix (or the eigenpairs of the correlation matrix); select the minimal POD dimension such that the projection error is smaller than a desired tolerance; compute unknown interpolation coefficients of RBFs for reduced space. Consequently, computation of system responses

corresponding to any arbitrary values of input parameters within POD-RBF procedure leads to simple matrix multiplication.

Various numerical examples for ODEs and PDEs demonstrate influence of different sampling strategy, number of samples, dimensionality of POD basis, types of RBF on tolerance of system responses.

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PLANNING OF A LESSON WITH APPLICATION OF INFORMATION TECHNOLOGY

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Technology enriched activity must be based on the ideas and concepts which ought to be taught by our curriculum. Technologies are a wonderful tool for acquisition, organization, assessment of knowledge.

Materials and resources – we shall determine: what learning materials do we need to teach a lesson? Which technological resources are available to run the class? Which additional equipment is required? Is the time enough for the whole class to finish the project/task at the computer? Is there a specialist at school, who can help us when working with technology? Do we need to create “instructions” for the pupils about how to use a computer software?

Additional questions: How should we group the pupils to perform the task at the computer? Do we, and the pupils need to acquire any technology-related skill prior to commencement of the activity? Are the technologies that we plan to use at the lesson in order? And the most important thing: Are the used technologies really a part of educational process, or do they only serve the purpose of using technologies?

Thus, through the use of technologies the teachers give opportunity to the pupils to obtain high-quality information.

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RECURRENT TIME-VARYING PARAMETER ESTIMATION BY LEAST SQUARES METHOD WITH LEAST DEVIATIONS FROM ‘ATTRACTION’ POINTS FOR BILINEAR DYNAMIC SYSTEMS UNDER UNCERTAINTIES

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The estimation problem of slowly time-varying matrices $A, B_1, B_2, \dots, B_m, B$ is considered for dynamic object

$$x(k+1) = Ax(k) + \sum_{i=1}^m u_i(k)B_i x(k) + Bu(k) + \xi(k), k \in \mathbb{N}, (1)$$

by least squares method with variable forgetting factor $\lambda(k)$ ($\lambda(k) \in (0,1]$) in non-classical case when this estimate may be not unique and additionally ‘attraction’ points $A_*(N), B_{1*}(N), B_{2*}(N), \dots, B_{m*}(N), B_*(N)$ for parameter matrices $A, B_1, B_2, \dots, B_m, B$ are given at any moment N ($N = 0, 1, 2, \dots$), where $x(k), u(k) = (u_1(k), u_2(k), \dots, u_m(k))^T, \xi(k)$ are state, control and errorvectors respectively.

The set of all above-mentioned estimates of unknown non-stationary matrices without using knowledge of ‘attraction’ points is defined as

$$\text{Arg} \min_{A, B_1, B_2, \dots, B_m, B} Q(A, B_1, B_2, \dots, B_m, B, N), \quad (2)$$

where $Q(A, B_1, B_2, \dots, B_m, B, N) = \sum_{k=1}^N w(k, N) \|\xi(k)\|^2$,

$$w(k, N) = \begin{cases} \prod_{i=k}^{N-1} \lambda(i), & \text{if } k = \overline{1, N-1}, \\ 1, & \text{if } k = N. \end{cases}$$

The needed least squares estimate with least deviations from given ‘attraction’ points at any moment N is obtained as unique estimate on estimate set (2) in this situation.

The recurrent algorithms for proposed least squares estimate with least deviations from given ‘attraction’ points and corresponding weighted residual sum of squares are suggested too.

SPECIAL TYPE OF DISTRIBUTION PROBLEMS²

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Transportation problems are a classic part of the Operation Research. The specific task we are presenting was lectured as a part of the subject Logistics Chains Designing taught at the Faculty of Military Leadership, University of Defence. The task was solved and we created a general algorithm for solving such problems.

Within the task the certain amount of several types of goods is to be transported from several specific supply points (warehouses) to one destination. The air transport over long distances is used. The task includes given distances from the warehouses to the destination, weights of each type of goods, their required quantities, price of the transport, and the capacity of the respective warehouses.

We solved the given task and found the optimal solution for the minimum transport costs. We also created an algorithm for solving this transportation problem that is general for this type of tasks. The author has never encountered this type of task in the literature. The problem is solved both by the proposed algorithm and using Solver in MS Excel.

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CONSTRUCTION OF THE JOBS BATCHES FOR OPTIMAL MODE IN FLEXIBLE MANUFACTURING

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For the purpose to synchronize the activity of the manufacturing shop and computer system we construct time environment of two kinds:

kind 1 – time is represented as corteges of quantum of time of different length (optimal mode, it takes the opportunity to organize parallel fulfillment of the optimal tasks);

kind 2 – quantum of time are equal (ordinary mode).

In the condition of usage of the artificial environment it is necessary to organize the transition from entrance batches of the parts to batches of the parts which come to the computer system and then the batches of the parts which manufactured. It needed to solve of some problems.

On the design stage we solve such problems as:

calculation of the minimum and maximum values of the sizes of the batch for every concrete part in optimal mode. These batches are the elements of the entrance in the optimal model. For the purpose to build the indicated limits the intelligent procedure named “Rationality” is used;

construction of the maximum stream of the batches of the parts (in case if every concrete part is represented with minimum value of it size) and calculation of the number of the needed computers.

On the control stage we solve such problems as:

if the number of the parts in the batch, which enter the system, exceed the maximum value, then forming of job for the ordinary mode in the manufacturing shop;

if the number of the parts in the batch be in the calculated limits, then forming of job for the optimal model, send it to the computer department. After calculations the results resend to the manufacturing shop.

The time of solving of the optimal problems in the computer system ought to be equal to the time of manufacturing of the batches of parts in the shop.

MARKOV MODEL FOR DESCRIPTION OF THE INTENSITY OF THE TERRORIST THREAT

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Terrorist attacks and threat of terrorism are connected with destabilization of the threatened societies. The statistical model enabling to predict the risk of the terrorist threat based on given determinants/indicators will be presented. The indicators of the threat of terrorism can be classified into the following categories: economical, social, demographical, political and security.

The model is based on the theory of discrete, time nonhomogeneous Markov chains with a finite state space. The theory of generalized linear models is used for estimation of probabilities of the categorized level of terrorist threat. Then the transition probabilities of Markov chain are chosen with regards to the value of the indicators for given time period and considered region. The computed transition probabilities are used for estimation of the intensity (risk category) of terrorism threat. The verification of the model is carried out via simulation. Other data used for model verification come from the Global Terrorism Database of University of Maryland. The computational implementation of the suggested model is carried out in the R programming language.

PROBLEMS OF ARTIFICIAL INTELLIGENCE, COMBINATORIAL OPTIMIZATION AND ARGUMENT OF THE OBJECTIVE FUNCTION

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Many applied problems from artificial intelligence are reduced to problems of combinatorial optimization. This is due to the fact that their predominant part in finding an optimal solution requires the parsing of options. The parsing problems are characteristic of combinatorial nature. This property can be investigated by simulating such problems within the framework of combinatorial optimization theory.

To simulate of the applied problems of artificial intelligence in the framework of the theory of combinatorial optimization it is necessary.

- define the type of the problem (static or dynamic) by the way of calculating the target function;
- identify base sets which is given a certain problem;
- determine the type of problem for the input data;
- define the argument of the objective function (combinatorial configuration);
- modelling the objective function.

Applied problems of artificial intelligence are complex in nature and are divided into independent subproblems that belong to different classes. The objective function in them depends on several variables, which are different types of samples or a partitioning an n -element set into subsets. To solve them, it are developed algorithms that combine two or more methods and are based on the organization of step-by-step calculations – an iterative process that generates a sequence of solutions in accordance with the built-in procedures. If the built-in procedures are independent algorithms focused on solving problems of certain classes, then they are called hybrid ones. The solution of the problem is determined on sets of combinatorial configurations of different types. In this case, the essence of the hybrid algorithm is to combine such methods to find the optimal solution that would be valid for each of the given combinatorial sets.

MATHEMATICAL MODEL OF DEPENDENCE BETWEEN PRESSURE AND DEFORMATION OF CONCRETE AND ITS COMPUTER SOFTWARE

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According to a well-known proposition, used in the present work: the function of several arguments is equal to the product of the functions of each argument:

$$F(v,t,w)=f_1(v)\cdot f_2(t)\cdot f_3(w)$$

The analysis has been done by processing own experimental data and other authors' materials on heavy concrete of various compositions with strength R_0 from 12 to 58 MPa.

The working graphs of the dependence R (lgu) for each concrete composition are constructed on the basis of these data for the selection

of the approximating function $f_1(v)$. The graphs represent straight lines that are described by the equation

$$R = R_0 + (\lg v - \lg v_0) \operatorname{tg} \alpha$$

Having constructed separate graphs of the dependence of $\operatorname{tg} \alpha$ (R) for several values of $\lg (v/v_0)$, there were obtained straight lines with different angles of inclination β , the value of which depends on $\lg (v/v_0)$, and determine on it the value $\operatorname{tg} \beta = \operatorname{tg} \alpha / R$.

The values of the coefficients A_1 , a_1 and m are determined and the joint processing of the entire array of experimental data by minimizing x^2 with respect to the parameters, included in formulas (7) and (8), is resulted in $A_1=0,098$; $a_1=0,0053$; и $m=1$.

A computer program has been compiled for their calculation.

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EMBEDDED SECURITY FOR INTERNET OF THINGS

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Embedded computing increasingly pervade our lives. But most of them are unsecured in nature. Security for these systems is an open question and could prove a more difficult long-term problem than security does today for desktop and enterprise computing. Security issues are nothing new for embedded systems. However, as more embedded systems are connected to the Internet, the potential damages from such vulnerabilities scale up dramatically. Internet connections expose applications to intrusions and malicious attacks. Unfortunately, security techniques developed for enterprise and desktop computing might not satisfy embedded application requirements. Internet connections expose applications to intrusions and malicious attacks. Unfortunately, security techniques developed for enterprise and desktop computing might not satisfy embedded application requirements. System designs for embedded devices are complicated, including multiple independent processor cores, secondary bus masters such as DMA

engines, and large numbers of memory and peripheral bus slaves. In addition to these functional components there is typically a parallel system infrastructure that provides invasive and non-invasive debug capabilities, as well as component boundary scan and Built-In-Self-Test (BIST) facilities. Due to this kind of importance as well as the pervasive deployment of embedded devices from home to big enterprises, embedded device security becomes a big issue. Many research initiatives have been undertaken to counter the issues of security in embedded systems. In fact, pervasive networks have led to widespread use of embedded systems, like cell phones, PDAs, RFIDs etc., in increasingly diverse applications. Many of these embedded system applications handle sensitive data) or perform critical functions (e.g., medical devices or automotive electronics), and the use of security protocols is imperative to maintain confidentiality, integrity and authentication of these applications. Evolution of embedded systems towards devices connected via Internet, wireless communication or other interfaces as well as the trend towards always growing numbers of devices (IoT) requires a re-consideration of embedded systems engineering processes. It is no longer possible to achieve the required level of security by adding security measures late in the development process.

RATE OF CONVERGENCE OF STATIONARY DISTRIBUTION FOR RETRIAL SYSTEMS WITH QUEUE

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A significant part of the queueing theory is the results on of systems with repeated calls (retrial queues). The detailed overviews of the related references with retrial queues can be found in [1], [2]. These systems are widely used as mathematical models for the real systems in economics, transport, computer network designing as well as in modern mobile communication systems etc.

Retrial queues are characterized by the following feature. When an arriving customer finds that all servers are busy and no waiting position is available, the customer joins a virtual 'orbit' and repeat its request after a random time until the customer gets into the service area. Such attempts become a source of repeated calls.

In this paper we consider a multiserver retrial queueing system with the finite number of servers, a finite length queue and an infinite orbit. Such a system can be denoted by a symbol $[M|M|m|m+n]$, where a rate of primary call flow λ_j depends on the number j - of customers in the orbit. The rates of repeated calls ν and of the service process μ are supposed to be constant. The effective approach to find a steady state distribution of the service process is proposed. It consists of two stages. At the first stage we construct the explicit vector-matrix form of the stationary distribution for the queue with finite orbit. At the second stage the stationary probabilities for the queue with infinite orbit are approximated by the formulae which are obtained at the first stage.

For threshold control strategies the optimization problem of the total income of the system was stated and solved. We deal with the consequences of result obtained for the case of one server and one place in the queue. The rate of convergence of stationary distribution of finite system involved one server and one place in the queue to this of infinite system under threshold strategies were obtained.

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MAIN PROPERTIES OF OPERATORS IN THE PROBLEM OF SURFACE POLLUTION DISTRIBUTION IN AGROLANDSHAFT

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Construction of difference schemes is a powerful tool for numerical solution of mass transfer equations with arbitrary initial boundary conditions. Considering the relevance of studying the movement of pollutants in the environment and the complexity of numerical implementation of its models, which includes the study of the correctness and stability of the received difference schemes, studies related to the construction of economic schemes for numerical analysis of surface pollution are important. The study examined model

$$\begin{aligned}
Zu &\equiv \frac{\partial u(x, t)}{\partial t} + Au + Bu \equiv \\
&\equiv \frac{\partial u(x, t)}{\partial t} - \sum_{i=1}^2 \frac{\partial}{\partial x_i} \left(D(x) \frac{\partial u(x, t)}{\partial x_i} \right) + \sum_{i=1}^2 V \frac{\partial u(x, t)}{\partial x_i} = -\lambda u_0 \phi(x) \delta(t-0), \\
u(x, 0) &= 0, \quad x \in \Omega, \\
\left(-\sum_{i=1}^2 D(x) \frac{\partial u}{\partial x_i} + Vu \right) \Big|_{x \in \Gamma} &= k(\Gamma) c_0 q_0(x), \quad t \in [0, T], \\
\left(-\sum_{i=1}^2 D(x) \frac{\partial u}{\partial x_i} + Vu \right) \Big|_{x \in \partial\Omega \setminus \Gamma} &= 0, \quad t \in [0, T]
\end{aligned}$$

in the area $Q = \Omega \times (0 \leq t \leq T)$, $\Omega \subset R^2$.

Was introduced space H with the norm $\|u\|_H = \int_Q (u_t^2 + \sum_{i=1}^2 \left(\frac{\partial u}{\partial x_i} \right)^2) dQ$.

Estimates were obtained for differential operators

$$\|Zu\|_{H^*} \leq c \|u\|_H, \quad \|Bu\|_Q^2 \leq 2\tilde{c}V^2 \|u\|_H^2, \quad \|Au\|_Q^2 \leq \tilde{c} \|u\|_H^2 + \tilde{K} \int_0^T \|u\|_{W_2^2(\Omega)}^2 dt.$$

Furthermore,

$$0 \leq \frac{\partial}{\partial t} \|u\|_{L_2(Q)} + \|Au\|_{L_2(Q)} + \|Bu\|_{L_2(Q)} \leq \frac{\partial}{\partial t} \|u\|_{L_2(Q)} + (c_1 + c_2) \|u\|_H.$$

In Ω_h introduced uniform grid for the two variables with a constant step h_1, h_2 in which ω_h - the set of internal nodes of a grid

$$\omega = \{x | x = (x_1, x_2), x_1 = i_1 h_1, x_2 = i_2 h_2, i_1 = \overline{1, N_1 - 1}, i_2 = \overline{1, N_2 - 1}, N_1 h_1 = L_1, i_2 h_2 = L_2\},$$

$\partial\omega$ - the set of boundary nodes. For grid functions defined space $\bar{H}$, in

$$\text{which } \|y\|_{\bar{H}} = \sqrt{(y, y)_{\bar{H}}} = \left(\sum_{x \in \omega} y_{ij}^2 h_1 h_2 \right)^{1/2}.$$

We put in correspondence the difference operator $A = -\sum_{i=1}^2 (Dy_{x_i})_{\bar{x}_i}$

for the operator A on the set of functions $y \in \bar{H}$, operator $B = \sum_{i=1}^2 Vy_{\bar{x}_i}$

– for the operator B .

Differential analogues of estimates were obtained for difference operators

$$\|By\|_{\bar{H}}^2 \leq 2V^2c\|y\|_{\bar{H}}^2, \quad (By, y)_{\bar{H}} \leq c\|y\|_{\bar{H}}^2,$$

$$(Ay, y)_{\bar{H}} \leq K\|y\|_{\bar{H}}^2, \quad \|Ay\|_{\bar{H}}^2 \leq K_1\|y\|_{\bar{H}}^2.$$

The operator-difference scheme of type

$$\frac{dy}{dt} + Ay + By = \phi,$$

$$y(x, 0) = 0,$$

$$-\sum_{i=1}^2 Dy_{x_i} + Vy|_{x \in \Gamma} = \phi_0, \quad -\sum_{i=1}^2 Dy_{x_i} + Vy|_{x \in \partial\Omega \setminus \Gamma} = 0,$$

was obtained as a result of discretization over space. For its canonical form (operators $\underline{B} = E + \sigma\tau \underline{A}$, $\underline{A} = A + B$ are not self-adjoint) it was received

$$\|\underline{Ay}\|_{\bar{H}}^2 \leq (M_1 + M_2)\|y\|_{\bar{H}}^2, \quad M_1 + M_2 = O(h_1^{-2} + h_2^{-2})$$

and $\underline{B} > 0$ under conditions $\tau(\frac{1}{h_1} + \frac{1}{h_2}) < (2\sigma D_{\max})^{-1}$.

All received estimates give an opportunity to show the correctness of

$$\|y^{(n)}\|_{\bar{H}} \leq \tau M.$$

APPLICATION OF QUANTITATIVE METHODS FOR RISK ASSESSMENT IN A SELECTED MEDICAL FACILITY

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The article deals with workplace risk assessment in a selected medical facility in the South Moravian region. Quantitative research, specifically questionnaire survey, has been carried out to collect the required data. As the main research methods were used; exploratory data analysis, correlation analysis and Chi-Square Test of Independence. The aim of the article is to assess the severity of individual risks and to confirm the hypothesis that each employee perceives risk identically. The greatest finding is the fact that majority of employees are in agreement about the significant risks. Among the most significant risks belong the risk of infection, lack of space or unsuitable workplace arrangement and overworking.

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MATHEMATICAL MODELLING OF SALT TRANSFER TO SYSTEM OF HORIZONTAL DRAINS IN ZONES OF COMPLETE AND INCOMPLETE SATURATION UNDER NONISOTHERMAL CONDITIONS

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The process is considered of salt transfer to a system of horizontal drains of deep and shallow occurrence in zones of complete G1 and incomplete G2 saturation under nonisothermal conditions (fig. 1).

The mathematical model of this problem in generally adopted specifications may be described by the boundary problem [1].

The numerical solution of the problem is found by a method of finite differences using the numerical method of conformal mappings in an inverse statement. As a result of the programmic implementation of the problem the distribution was found of the field of the concentration of salt solutions to the system of horizontal drains of deep and shallow occurrence the change is researched of the positions of free surfaces.

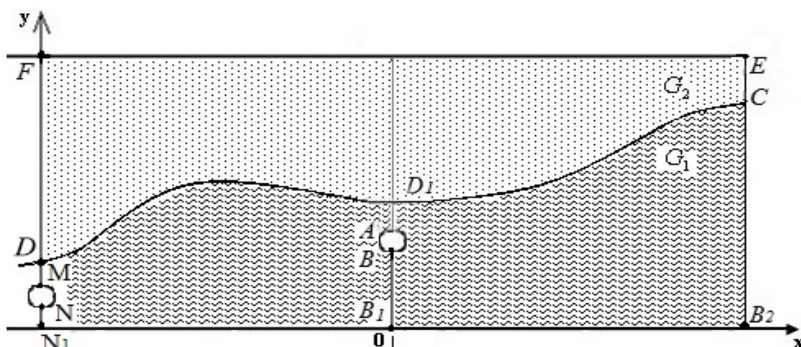


Fig. 1. Salt transfer to system of horizontal drains in saturated-non-saturated soil mass under nonisothermal conditions

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PRICE OPTION MODELING ON THE BASE OF BLACK-SHOLES EQUATION

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The article deals with the modeling of an option price dynamics in finite price interval $[X_1, X_2]$ its basis stock and its finite time interval $[0, t^*]$ on the base of Black-Sholes Equation [1]:

$$\frac{\partial w(x, t)}{\partial t} + \frac{1}{2} \sigma^2 x^2 \frac{\partial^2 w(x, t)}{\partial x^2} + r x \frac{\partial w(x, t)}{\partial x} - r w(x, t) = 0, x \in [X_1, X_2], t \in [0, t^*],$$

$$w(x_i, t) \Big|_{t=t^*} = 0, x_i \in [X_1, x^*], w(x, t) \Big|_{t=t^*} = x - x^*, x \in [x^*, X_2], i = \overline{1, n},$$

$$w(x, t_j) \Big|_{x=X_1} = 0,$$

where $w(x, t)$ – price of option, x^* – price of basis stock indicated in an option, t^* – time of buying a basis stock, σ – volatility, r – risk-free interest rate. We will assume that the additional conditions are not

sufficiently defined. We made the replacement of variables and reduced the Black-Scholes model to a homogeneous parabolic model with a known fundamental solution $G(x - x', t - t')$ differential equation.

According to the method proposed in [2], let's move from a parabolic model to an integral one with unknown functions $\omega_0(\cdot)$, $\omega_T(\cdot)$

$$w(x, t) = \int_{-\infty}^{0_1} dt' \int_{X_1}^{X_2} G(x - x', t - t') \omega_0(x', t') dx' + \\ + \int_0^t dt' \int_{R[X_1, X_2]} G(x - x', t - t') \omega_T(x', t') dx'.$$

We will discretize this function by variables (x, t) , (x', t') or (x, t, x', t') .

We will require that the additional conditions are satisfied by mean-square criterion. Then we obtain the model of the option price in the matrix-integral, matrix-functional, or algebraic form. Unknown functions will be constructed by the method of pseudo-inversion of the systems of integral, functional or algebraic equations [2].

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THE EVOLUTION OF FINANCIAL SYNTHETIC INDICATORS

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Synthetic indicators are generalized indicators in financial economics. Let's consider a country. Suppose the administrative division in this country predict n regions. And we know the synthetic indicators in all of them for three years, and these years are in sequence. During these three years, the synthetic indicator was changed twice. During this evolution the value can increase, decrease or be constant. In accordance,

we can divide all regions into classes. This allows to deal with regions with similar change of the synthetic indicators. Classification can be the following: the first class contain regions, where there is observed increase and decrease of the synthetic indicator, the second – only decrease, the third - decrease and increase, the fourth – only increase, in the fifth class the synthetic indicator is changed only in the third year, in comparison with the second year, moreover, this change is decrease, in the sixth class in the first change the indicator is permanent and in the second change this indicator increase, in the seventh class we observe decrease, but later it becomes permanent, in the eight class firstly we can see increase and then the synthetic indicator is constant, and the last ninth class contain regions, where synthetic indicators are permanent during all three years.

At result, we create the matrix of transitional probabilities and calculate financial synthetic indicators for the next years.

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MODELING AND OPTIMIZATION OF CRYOGENIC-OPTICAL GRAVIMETERS

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This report focuses on the problem of designing and developing optical-cryogenic devices using new physical principles, mathematical methods, and new superconducting materials. The sensor element is based on new controlled magnetic levitation phenomenon, high-precision optical registration of mechanical coordinates of levitating body, and the robust signal processing tools. A controlled self-bearing probe dynamics is also analyzed. We have shown how to produce reliable YBCO thin films with controllable surfaces and physical properties and how to integrate them in a ring form into the optical-cryogenic gravimeter so as to reduce its size and render it convenient for future space applications. This report also focuses on modeling and optimization problems. This report starts with the physical basis and a brief description of the system identification approach. Following that,

several examples illustrate practical issues in temporal and spatiotemporal prediction, NARMAX and bilinear modeling. This report concerns improvement and new development of models based on data driven modelling, such as BILINEAR and NARMAX. The following methods and models have been proposed: (a) dynamical-information approach to NARMAX system identification; (b) combination of NARMAX model and Lyapunov dimension; (c) guaranteed prediction; (d) robust models; (e) risk assessment in safety analysis.

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MULTICRITERIA DECISION-MAKING PROBLEMS UNDER FUZZY CONDITIONS

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Multi-criteria decision-making problems represent wide class of decision-making tasks. For its solution under certainty were developed a lot of methods and algorithms. But the problem of multi-criteria decision making substantially aggravates under uncertainty if criteria and constraints become fuzzy. For such problems the development of special methods and algorithms is of great need.

The goal of this report is formulation and investigation of multi-criteria non-linear decision making problems (MCNP) under fuzzy conditions and development method of their solution on the base of so-called non-compromise solutions of MCNP-problems.

Consider the multi-criteria decision-making problem under fuzzy conditions

$$\max\{f_i(X, C_i), i=1, m\} \quad (1)$$

under constraints

$$X \in G(A) = \{X : g_k(X, a_k) \leq 0, k = \overline{1, K}\}, \quad (2)$$

where $X = [x_j], j = \overline{1, n}; C_{ij} = [c_{ij}], j = \overline{1, n} \quad a_k = [a_{kr}] k = \overline{1, K}, r = \overline{1, R}, c_{ij}$

- fuzzysets (FS) with known membership function (MF), $a_k = [a_{kr}]$ - FS with MF $\mathcal{G}(a_{kr})$.

Call such problem “multi-criteria non-linear programming problem (MCNP)”. Using analogy with non-fuzzy problems let’s introduce Pareto-optimal solution of α -level. As Pareto-optimal solutions of α -level set is very large, therefore problem arises of choosing one of them which will be optimal in some sense. Therefore it’s suggested to introduce so-called the best compromise solution of (MCNP).problem of α -level.

The theorems, determining interconnections between Pareto-optimal solutions and the best compromise solutions of (MCNP) problem of α -level are formulated and proved. In the report investigations of the best compromise solution of MCNP problem of α -level and it’s application for the solution of practical multi-criteria fuzzy problems are presented and discussed.

MATHEMATICAL MODEL OF A RIGID-BODY DYNAMICS IN AN AXIALLY SYMMETRIC MAGNETIC FIELD

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The basic theoretical results [1,2] in rigid-body dynamics with quaternions were presented. In particular the Poisson structure in quaternion variables is

$$\begin{cases} \{x_i, x_k\} = 0, \{x_i, q_\mu\} = 0, \{x_i, \Pi_j\} = 0; \\ \{p_i, q_\mu\} = 0, \{p_i, \Pi_j\} = 0; \\ \{x_i, p_k\} = \delta_{ik}, i, k = 0, 1, 2; \\ \{q_\mu, q_\nu\} = 0, \mu, \nu = 0, 1, 2, 3; \\ \{\Pi_i, q_0\} = q_i; \\ \{\Pi_i, q_j\} = -q_0 \delta_{ij} - \varepsilon_{ijl} q_l; \\ \{\Pi_i, \Pi_j\} = -2\varepsilon_{ijl} \Pi_l. \end{cases} \quad (1)$$

For Hamiltonian

$$H((\mathbf{x}, \mathbf{p}), (q, \Pi)) = \frac{1}{2m} \mathbf{p}^2 + T_{spin}((\mathbf{x}, \mathbf{p}), (q, \Pi)) + V(\mathbf{x}, q), \quad (2)$$

where

$$T_{spin}((\mathbf{x}, \mathbf{p}), (q, \Pi)) = \frac{1}{8} \Pi \mathbb{I}^{-1} \Pi = \frac{1}{8} \left(\frac{\Pi_1^2}{I_1} + \frac{\Pi_2^2}{I_2} + \frac{\Pi_3^2}{I_3} \right), \quad (3)$$

$\mathbb{I}$ – tensor of inertia in the body frame (matrix of diagonal elements I_1, I_2, I_3); $\Pi = 2\mathbf{M}$ (M_i – components of angular momentum) the motion equations from [1]:

$$\begin{cases} \mathbf{x} = \frac{1}{m} \mathbf{p}; \\ \mathbf{p} = -\partial_{\mathbf{x}} V; \\ \dot{q} = \frac{1}{2} q \boldsymbol{\Omega} \rightarrow q^{-1} \dot{q} = \frac{1}{2} \boldsymbol{\Omega}; \\ \Pi = -\mathcal{J}(\boldsymbol{\Omega} \Pi + q^{-1} \nabla^{(q)} V), \end{cases} \quad (4)$$

where $\mathcal{J}()$ –quaternions vector part; x_i – coordinates of rigid body center of mass, $q = (q_0, \mathbf{q})$ – unit quaternion describes the rotation from inertial frame of reference to the body frame, p_i – linear momentum components, Π_i – angular momentum components in the body frame.

Dynamics of system (4) corresponds to a motion of a magnetized rigid body in an axially symmetric magnetic field if q satisfies the equality

$$q_0^2 + q_1^2 + q_2^2 + q_3^2 = 1. \quad (5)$$

However, condition (5) leads to the well known problem of numerical simulation of motion equations. Problem usually solved by creation of special geometric integrator. This work is about an integrator proposed for solve this problem.

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