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THE INVERSE PROBLEM FOR HYPERBOLIC EQUATION IN A DOMAIN WITH MOVING BOUNDARY

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The goal of this paper is to study the well-posedness of an inverse problem of determining the unknown coefficient on the right side of hyperbolic equation. The inverse problem in a domain with moving boundary in case of the Dirichlet boundary condition with additional integral information.

We consider an inverse problem of determining a pair of functions

$$\{f(t); u(x, t)\}$$

from conditions

$$u_{tt} - u_{xx} = f(t)g(x), (x, t) \in D = \{s_1(t) < x < s_2(t), 0 < t \leq T\},$$

$$u(x, 0) = \varphi_1(x), u_t(x, 0) = \varphi_2(x), x \in [s_1(0), s_2(0)],$$

$$u(s_1(t), t) = \psi_1(t), u(s_2(t), t) = \psi_2(t), t \in [0, T],$$

$$\int_0^{\gamma(t)} u(x, t) dx = h(t), t \in [0, T],$$

where the data $g(x)$, $\varphi_1(x)$, $\varphi_2(x)$, $\psi_1(t)$, $\psi_2(t)$, $h(t)$ and $\gamma(t)$ are continuous functions whose degree of continuity we shall make precise later. Recall that we have assumed that $s_i(t) \in C^1([0, T])$, $i = 1, 2$; $s_1(t) < \gamma(t) < s_2(t)$, $t \in [0, T]$. Here, we shall also assume that

$$\inf_{0 \leq t \leq T} |s_1(t) - s_2(t)| > 0, \sup_{0 \leq t \leq T} |s_1(t) - s_2(t)| < \infty.$$

In the paper, the uniqueness of solution for considering problem is proved under more general assumptions and the estimation characterizing the "conditional" stability of the problem is established.

BRANCHING PROCESS WITH MEAN ONE AND INFINITE VARIANCE

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Consider the simple branching process ξ_n with the non-negative integers as state spaces i.e. ξ_n is the size of the n -th generation and $f_n(s)$ is the corresponding generating function.

Let $p_n(i, j)$ is n -step transition probabilities of ξ_n and

$$f(s) = \sum_{k=0}^{\infty} p_k s_k = M\left(s^{\xi_1} \mid \xi_0 = 1\right), \quad |s| < 1,$$

p_k -density of probabilities.

Assume that $p_1 \neq 1$ and the mean

$$f'(1) = \sum_{k=0}^{\infty} k p_k = 1.$$

Then $f_n(s)$ increases to 1 as $n \rightarrow \infty$, for every $s \in [0, 1)$. In this work we consider the partial case, when generating function the following form

$$f(s) = s + (1-s)^{1+\alpha} L(1-s), \quad |s| < 1, \quad (1)$$

where $L(x)$ is slowly varying as $x \rightarrow 0$ and $0 < \alpha \leq 1$. This includes the case $f''(1) < \infty$, when $\alpha = 1$ and $L(x) \rightarrow \frac{1}{2} f''(1)$ as $x \rightarrow 0+$. Denote

$$F_n(u) = M\left[e^{-u(1-f_n(u))^{\xi_n}} \mid \xi_n > 0\right], \quad u > 0.$$

The following limit theorem is proved.

Theorem. If (1) holds, then

$$F_n(u) \rightarrow F(u) = 1 - u\left(1 + u^\alpha\right)^{-\frac{1}{\alpha}} \text{ as } n \rightarrow \infty.$$

Corollary. $\lim_{n \rightarrow \infty} p\left[(1-f_n(0))^{\xi_n} < x \mid \xi_n > 0\right] = G(x), \quad x \geq 0,$ where

$G(x)$ has the Laplace transform $F(u)$.

A RETRIAL DISCRETE-TIME QUEUEING SYSTEM WITH ACTIONS IN THE SERVER

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This paper considers a discrete-time retrial queueing system with movements. The arriving customers can opt to go directly to the server obtaining immediately their service or to join the orbit. In the first case, if the server is busy, the customer that is in the server is displaced to the orbit. The arrivals follow a geometrical law and the service times are general.

We study the Markov chain underlying the considered queueing system obtaining the generating function of the number of customers in the orbit and in the system as well as the stationary distribution of the time that a customer spends in the server. We derive the stochastic decomposition law and as an application we give bounds for the proximity between the steady-state distributions for our queueing system and its corresponding standard system.

At time $m+$ the system can be described by the process (C_m, ξ_m, N_m) where C_m denotes the state of the server, 0 or 1 according to whether the server is free or busy and N_m the number of repeated customers. If $C_m = 1$, then ξ_m represents the remaining service time of the customer currently being served.

It can be shown that $(C_m, \xi_m, N_m) : m \in \mathbb{N}$ provides a Markovian description of the queueing system under study, whose states space is $\{(0, k) : k \geq 0; (1, i, k) : i \geq 1, k \geq 0\}$.

The main objective of this work is to find the stationary distribution

$$\begin{aligned}\pi_{0,k} &= \lim_{m \rightarrow \infty} P[C_m = 0; N_m = k], k \geq 0 \\ \pi_{1,i,k} &= \lim_{m \rightarrow \infty} P[C_m = 1; \xi_m = i; N_m = k], i \geq 1, k \geq 0\end{aligned}$$

Markov chain $\{(C_m, \xi_m, N_m) : m \in \mathbb{N}\}$.

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THE AESTHETICS OF ART OF ETHICAL DECISION-MAKING IN SOCIAL WORK PRACTICE

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The present scientific paper outlines understanding the artistic nature of ethical decision making entails aesthetic judgment. According to Georgian Philosopher Irma Bagrationi's work "Konstantine Kapaneli's Philosophical and Aesthetical Conceptions" Aesthetics is generally defined as "the philosophical study of beauty and taste" [2]. As we know, the word is derived from the Greek "aisthanesthai" - to perceive, and "aisthetica" - things perceptible. The term "aesthetics" was introduced into philosophical parlance about the middle of the 18th century by German philosopher Alexander Gottlieb Baumgarten [4]. Aesthetics entails the study of the ways in which individuals perceive, judge, assess, evaluate, or comment about works of art - not just art in the narrow sense, such as paintings, but creative works of any sort.

The paper emphasizes, that philosophers who study aesthetics have taken several broad approaches that have implications for social work in general and social work ethics in particular. One approach is quite abstract and involves the study of aesthetic concepts and the language of aesthetics. For example, "what do we mean when we conclude that a particular painting, sculpture, or poem is beautiful? How should beauty be defined? Can it be defined? What constitutes beauty?" [5] - clearly we can ask comparable questions about ethical analyses and decisions in social work ethics. What constitutes an elegant ethics analysis and decision? What criteria shall we use when we render such judgments? A second approach focuses on the state of mind - such as individuals' responses, attitudes, and emotions - that are part of the aesthetic

experience. In the art and literary world, we ask about how viewing a particular painting or hearing a particular poem moves us emotionally in a way that reflects its aesthetic qualities [6]. By way of comparison, we know that in some instances we are truly inspired and moved by social workers' ethics-related analyses and insights. One other major approach to aesthetics involves study of the aesthetic object itself. In this domain, philosophers study particular paintings, books, plays, poems, and sculptures to assess their aesthetic qualities. The goal is to assess their beauty or other relevant qualities, just as social workers might assess the aesthetics of ethical analyses and decisions.

The paper discusses, that Sometimes we marvel at the remarkable skill colleagues demonstrate when they make ethical decisions. In the hard cases, talented social workers have impressive instincts and conceptual ability when they try to sort out the best approach to tangled moral dilemmas. Here's an example: "The clinical director recognized that hiring the former clients offered benefits but posed several ethical challenges that she wanted the group to consider. For example, the former clients who would become employees would develop professional relationships, as colleagues, with other staffers who were once their service providers. In addition, there was a possibility - no matter how remote - that a former client who becomes an employee would need to return to client status, further creating boundary - related challenges. Also, former clients who become employees might encounter current clients with whom they once received services, such as group counseling. Furthermore, the agency had to take steps to ensure that the former clients who become employees respected the confidentiality of people they knew when both were clients. For more than two hours we had the privilege of participating in a remarkably thoughtful discussion among the staffers as they developed comprehensive and rigorous ethics and risk-management guidelines and protocols. It was a thing of beauty" [1]

The paper tells us on practical beautiful ethical decision making: what, we thought, makes an ethical decision beautiful? Is this akin to our judgments about beautiful works of art, music, literature, and poetry? What criteria can we use to assess such beauty? The concept of art and the metaphor of the artist appear throughout social work. We sometimes speak of a clinician's uniquely effective and novel intervention in a complex case as "artistic". The same is true of a community organizer's artistic efforts to empower neighborhood residents who advocate for affordable housing in their social work

researcher's remarkably creative and illuminating analysis of complex data. According to Georgian Philosopher Ibraim Didmanidze's work "The Issue of Student Distance Communication and Collaboration (For Foreign Language Teaching)" "social work is an art, or it is worse than nothing" [3]. The author concludes that it becomes clear that there are substantial grounds for locating social work within the tradition of art. Art offers recognition and exploration of the ephemeral nature that marks the subject matter of all social work; it knows the practices of selection and synthesis which social workers must undertake if their understanding is to be adequately complex and coherent. Thus, Art strengthens social work's theory.

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DECISION-MAKING ON SELECTION OF APPLICANTS TO STUDY FOR A MASTER'S DEGREE IN LAW

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The problem of objective evaluation of entrants is important for quality assurance of higher education in Ukraine. This is especially true for training by educational programs that provide access to regulated professions. Law degree programs are the typical example of such programs. Since 2017 entry to study at the expense of the state budget is based on external independent evaluation which consists of three components – general legal competency test, law test and foreign language test. Due to differences in bachelor's degree programs in different higher education institutions, differences in legal specializations, random factors, etc., there is some uncertainty about interpretation of testing results. Therefore, different measures of evaluating the validity of the test as a whole and the quality of each of the tests tasks are used as characteristics of their suitability for evaluating and comparing applicants.

Comparison of testing results for different groups of entrants shows that there are statistically significant differences between the different types of higher educational institutions (classical, legal, technical, pedagogical, economical, ... universities), bachelor's specialties, years of graduation, etc. However, in almost all cases there are wide areas of intersection of results distributions. Therefore, assuming that the results of external independent evaluation are valid, there is no reason to restrict access to masters programs in law on the basis of a previously acquired specialty, profile of higher education institution and other factors.

Prognostic validity is one of the most important characteristics of evaluation results. For external, independent evaluation of applicants to the law degree, it was calculated as the correlation coefficient between the competition score, which was defined as the sum of the results of the three tests, and the average score for the first year of study in the magistracy. The analysis shows that there is a large variation of this indicator between higher education institutions – from statistically insignificant to over 0.6, which is considered as high values for prognostic validity.

ON CONJUGATE TRIGONOMETRIC SERIES

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Below we suppose that $T = [-\pi, \pi]$ and functions $f: R \rightarrow R$ 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.

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

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

where

$$a_k \equiv a_k(f) = \frac{1}{\pi} \int_T (t) \cos ktdt, \quad k \in N,$$

$$a_k \equiv a_k(f) = \frac{1}{\pi} \int_T (t) \sin ktdt, \quad k \in N,$$

$$b_k \equiv b_k(f) = \frac{1}{\pi} \int_T (t) \sin ktdt, \quad k \in N.$$

We imply, that

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

If $p \in [1, +\infty]$ and the function $f \in L^p(T)$, than

$$\|f\|_p = \left\{ \frac{1}{2\pi} \int_T |f(t)|^p dt \right\}^{\frac{1}{p}}, \quad p \in [1, +\infty].$$

Therefore $L^\infty(T) \equiv c(T)$ and

$$\|f\|_c = \|f\|_\infty = \sup_{x \in T} |f(x)|.$$

If $f \in L^p(T)$, $p \in [1, +\infty]$ and $\delta > 0$, than 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 .

Let's note that

$$\omega(\delta, f)_c = \omega(\delta, f)_\infty.$$

If function $f \in L(T)$, and $\delta > 1$ is any number, than with $t_n^\alpha(x, f)$ symbol we denoted Cesaro means of $\bar{\sigma}[f]$ series, α order, or

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

where

$$\tau_n^\alpha(x, f) = \frac{1}{A_n^\alpha} \sum_{k=0}^n A_{n-k}^{\alpha-1} \bar{D}_k(t), \quad \bar{D}_k(t) = \sum_{k=1}^n \sin kt,$$

$$A_n^0 = 1, \quad A_k^\alpha = \frac{(\alpha+1)(\alpha+2)\dots(\alpha+k)}{k!}, \quad k \in \mathbb{N}.$$

Below $A(\alpha)$, $A(p)$, $A(\alpha, p)$ they indicate absolute or positive values, depending on indicated parameters.

Theorem 1. Let $p \in]1, +\infty[$ and $f \in C(T)$. Then

$$\|t_n^{\frac{1}{p}}(f) - \bar{f}_n\|_c \leq A(p) \left\{ \omega\left(\frac{1}{n^{\frac{1}{1-\frac{1}{p}}}}, f\right)_c + n^{\frac{1}{p}} \omega\left(\frac{1}{n}, f\right)_p (\ln n)^{1-\frac{1}{p}} \right\}, \quad n \geq 4.$$

Theorem 2. Let $\alpha \in]0, 1]$, $\alpha p > 1$ and $f \in C(T)$. Then

$$\|t_n^{-\alpha}(f) - \bar{f}_n\|_c \leq A(\alpha, p) \left\{ \omega\left(\frac{1}{n^{1-\alpha}}, f\right)_c + n^\alpha \left(\omega\left(\frac{1}{n}, f\right)_c \right) \right\}, \quad n \geq 4.$$

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ON A THREE-STEP METHOD WITH AN ORDER OF CONVERGENCE $1+\sqrt{2}$ FOR SOLVING SYSTEMS OF NONLINEAR EQUATIONS BASED ON STEFFENSEN'S METHOD

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Let consider the system

$$P(x) = 0, \text{ where } P: R^n \rightarrow R^n. \quad (1)$$

To solve equation (1), a method that belongs to the class of multistep schemes or methods with memory proposed in [1] for the first time

$$\begin{aligned} x_{k+1} &= x_k - [P'(\theta_k)]^{-1} P(x_k), \\ \theta_{k+1} &= x_{k+1} - \frac{1}{2} [P'(\theta_k)]^{-1} P(x_{k+1}), \\ k &= 1, 2, \dots \quad \theta_0 = x_0. \end{aligned} \quad (2)$$

In the literature, this iteration scheme is often called the method with rate of convergence of $1+\sqrt{2}$. An advantage of this method is that, in each iteration, it requires practically the same amount of calculations as the Newton's method and at the same time has a higher rate of convergence.

In the present work, using the idea of construction of three-step method [2] and based on Steffensen's method, we propose the following method of solution of problem (1):

$$\begin{aligned} x_1 &= x_0 - [P(x_0, x_0 + \lambda P(x_0))]^{-1} P(x_0), \\ v_k &= x_k - [P(\theta_{k-1}, \theta_{k-1} + \lambda P(x_k))]^{-1} P(x_k), \\ u_k &= x_k - [P(\theta_k, \theta_k + \lambda P(x_k))]^{-1} P(x_k), \\ x_{k+1} &= \arg \min \|P(u_k + \lambda_k(v_k - u_k))\|, \quad \theta_k = \frac{v_k + x_k}{2}. \end{aligned} \quad (3)$$

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METHODS OF USING WIRELESS NETWORK

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Nowadays wireless technologies are widely used in the world to satisfy a big amount of consumers' communication requirements. There are different kinds of wireless connections, but the main feature of the wireless networks is the connection between computer devices. Most of manufacturers integrate antennas and network interface cards (NIC) which is known as network adapter, into computers so that they are invisible for consumers. All these make wireless devices more mobile and convenient to use.

Wireless global networks have unlimited working area which is provided by telecommunication companies. Agreements between telecommunication operators regarding roaming makes long distance connection able and provides fast data transferring between mobile consumers. A consumer is able to make connection with different Internet services in any point of the world with the help of wireless global networks only after paying to one telecommunication company.

Wireless local networks stand out with their high features, it provides information transferring outside an office, which is located in one big building. Consumers of such networks usually use PDA, laptops and PC-ies with large monitors and processors which are able to work with big systems. Such networks completely meet the requirements for such type of computer devices connection parameters.

To judge the future perspectives from consumer point of view, the borders between types of wireless networks must disappear. Special adapters of computer devices have already been created which have the support for different types of wireless networks.

TO THE REFORM OF THE UKRAINIAN EDUCATION IN TEACHING MATHEMATICAL DISCIPLINES

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Methods of mathematical modeling and optimization are penetrating into all spheres of human activity, including the processes of reforming education and improving the quality of learning to prepare a person for life in the globally computerized world of cloud infrastructures [1]. The problems of reforming the Ukrainian school and improving the quality of in-depth study of natural sciences and mathematics were actively involved with the NAPS, NAS and NAHE of Ukraine. Together with the specialists of the MES of Ukraine and representatives of public organizations, the priority of the tasks was to improve the quality of mathematical education in the preparation of highly qualified specialists to ensure the competitiveness of Ukraine in the international arena. Taking into account the needs of modern science and the needs of practice, legislative support for the development of natural and mathematical education and advanced study of mathematics and informatics has been created [2]. It is important that modern computer-aided learning technologies make it easier to acquire knowledge in higher mathematics as early as high school (integro-differential Newton-Leibniz calculus, basics of probability theory, applied statistics, (Newtonian) optimization methods, etc.). Today Japanese students master methods of building algorithms and programs to optimize complex processes, for example, to improve the playing skills of a robot football player. After all, such programs are also close to the optimized government software at national and even international levels. The report examines the challenges and practicalities of optimizing curricula and teaching methods most important in preparing a person for life in the 21st century - for living in a globally computerized world of cloud infrastructures.

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MATHEMATICS LEAD TO THE HIGHEST SPORTS ACHIEVEMENTS

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Mathematical modeling and optimization methods are increasingly used to achieve the highest sporting results at World Championships and World Olympiads, in particular in tennis and other gaming. These methods solve the problems of optimal preparation for the competition and the problem of optimization of game strategies by the criteria of maximizing the probability of winning, taking into account the indicators of athletic skill of each individual opponent. Analyzing decision-making processes in the context of incomplete knowledge, Pythagoras concluded: "Where there is no number and measure, there is hoas and chimeras." It is known that the skill of a tennis player is evaluated by the values: feed rate; accuracy of submission; speed and accuracy of forhand and backhand; the speed and accuracy of the mixture. Almost everyone understands the concept of impact velocity equally, but the "accuracy" everyone understands in its own right. In addition to these eight, there are still about a hundred other characteristics of stroke skill in more adequate mathematical model.

To dispel misconceptions, a mathematical model of cause and effect dependence of the numerical value of the probability of winning on the numerical values of the tennis player's skill and the permissible game strategies is constructed and optimized. The constructed mathematical model is the basic tool for finding the necessary numbers and measures by which optimal strategies in differential tennis games are built. Using the model built, and using identification methods to evaluate model parameters, we evaluate the values of tennis players' sporting skill parameters and calculate optimal strategies for playing big tennis by maximizing the chances of winning tennis matches.

METHODS OF CONSTRUCTION OF GENERALIZED OPTIMIZED TRAJECTORIES

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Numerical algorithms for finding optimal control of nonlinear processes with distributed parameters are usually constructed either by linearization methods (for approximation of controlled processes with distributed parameters by processes with lumped parameters) or by using discrete approximations of all partial derivatives (with the aim of determining). Linearization methods are based on the use of a discrete subset of the admissible domain, the elements of which allow to approximate derivatives of spatial variables with adequate precision adequate to their discrete approximations and to reduce the problem of controlled process optimization with distributed parameters to the optimization problem with control center. Similarly, by adequately selecting an expanded discrete subset in the entire cylindrical region (with the added time coordinate), the original optimal control problem is reduced to a unified PDO. In the case of piecewise differential optimal control, its approximate value is refined by the accelerated algorithms of pseudospectral methods. To this end, a set of Legendre-Gauss-Lobato points (LGL) is selected in the time interval and the required optimal controls and optimal phase trajectories are approximated by the Lagrange interpolation polynomials by the values in the LGL points. However, in the case of a non-convex set of admissible velocities of the phase trajectory, there may be no optimal control in the class of measurable functions, and therefore we construct a generalized optimized phase trajectory that exists on the set of equations in the contingencies given on a closed envelope of the velocity eigenvalues. Algorithms for the calculation of the generalized optimized trajectory of the corresponding equation in contingencies are constructed, and sequences of piecewise optimal controls are generated along this trajectory, which generate a sequence of phase trajectories that converges to a generalized optimized trajectory.

THE ASYMPTOTIC OF THE PROBABILITY OF BANKRUPTCY IN CASE OF LARGE PAYMENTS AND EXISTING INTEREST RATES ON RESERVE CAPITAL

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The asymptotic behavior of bankruptcy probability in case of large payments is considered, in particular, in [1], the asymptotics of bankruptcy probability for Pareto, Weibull, Benktander type I and II distributions are shown in that paper. However, these results do not work if there is an interest rate on the reserve capital.

The risk process in the case of the classic Kramer-Lundberg model, where in addition to insurance fee, the insurance company receives interest rate on reserve capital $\delta > 0$ defined as

$$U_{\delta}(t) = ue^{\delta t} + c \int_0^t e^{\delta v} dv - \int_0^t e^{\delta(t-v)} dS(v), t \geq 0,$$

where $S(t) = \sum_{n=1}^{N(t)} X_n$, the intensity of insurance fee $c > 0$, u – initial capital. [2]

Kluppelberg and Stadtmuller [3] have studied such a model when the distribution function $F(x)$ has "tails" that change regularly.

We, taking into account [3], find the probability of bankruptcy in the case of payments having Pareto and Benktander distributions.

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DECISION SUPPORT ELECTRONIC SYSTEM FOR CITY MANAGEMENT

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One of the sections of decision support electronic system for city management – demography is offered by the example of City Rustavi.

The main demographic indexes are described, such as: the number of population, the number of born alive, the number of deaths of newborn babies, stillbirth, the number of deceased persons according to the age, natural increase, marriage, social and economic status of population, the country's unemployment level in the region, educational data, conception for the development of automatized management support databases for economic resource provision for the city.

The scientific analysis has been conducted in certain systemic calculations of the processed statistic data, by which the right decision algorithm is defined in the management process of the city.

The main field of the base of city management systemic analysis consists of those indexes, which are necessary for systematization of management process

The information given by the mentioned and following fields should provide how to function a system which will help the manager to make a right decision and to see a possible danger.

We log into a system by means of internet browser created by us, where complete information is provided. The city manager may have the mentioned information, but to systematize is the principal process. We see the main fields from the opened WebPages, which are necessary in the management process of demographic problems of the city.

Upon log into a main field of population and demography, the fields are closed or the new pages are opened, where the main field is “population and demography”. Information provided in these fields are the notifications required for city management and development.

The field of demography includes the some fields such as: birth, death, natural increase and etc. image 1.

This field “subfield of born alive” shows statistic data list variations (as current as statistic) according to the years.

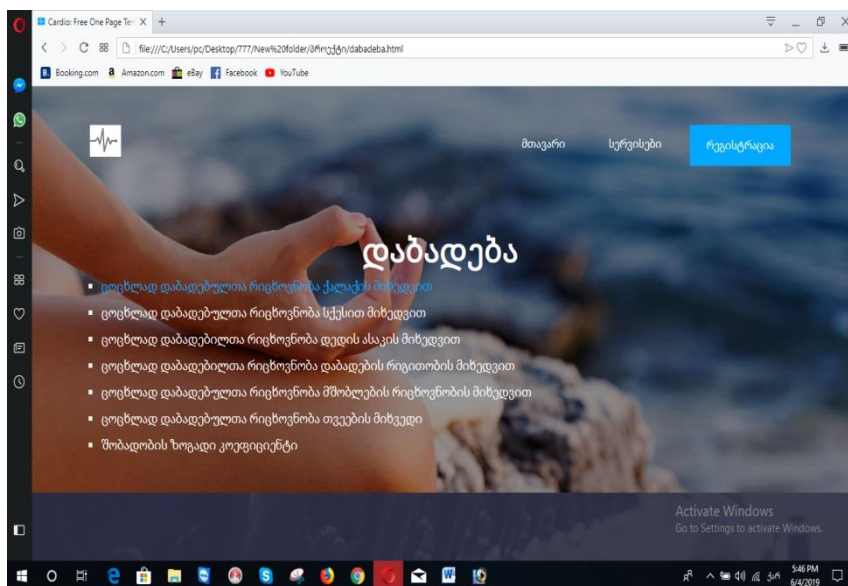


Image 1.

We showed by working of support information system of indicative management of social-economic processes of the city processed by us with the above fields in an interactive regime, what the great meanings have such systems which help the city manager to conduct social-economic status analysis of the city in an easy way, to see dangers, to find ways of solving them and to make affective decisions.

DECISION-MAKING MECHANISM IN SECURITIES TRADING

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Georgian Stock Exchange was founded in 1998 with the support of the US government and in particular the best American experts in this field. In the same year, the Georgian Parliament passed the Law on the securities market, which was recognized by foreign experts as one of the

best laws in the Soviet Union. The main point of the law was that the securities industry was separated from the public and private banking sectors. This was a step towards democratization, which helped to develop the securities industry independently. By law, banks were not allowed to participate in the stock exchange on their own, and any stock market owner was entitled to own up to 10% of the stock exchange. The supervision of this law was carried out by the Georgian Independent National Securities Commission. In addition to this supervision, the Commission also promoted the development of the securities market.

Once the law was launched, investors were involved in the case, and the securities market participants were able to make their investment decisions independently.

Due to the lack of experience in this field in Georgia, the need for consultancy services was established and stock exchange professional consultants' offices were put in place, providing recommendations to those wishing to apply. This has had a special effect on the stock exchange.

Despite such measures, the functioning and development of the Georgian Stock Exchange today is not at the level needed for the sustainable economic development of the country.

One of the major problems that obstructs the development of the securities market is that there is no modern decision-making mechanism in place such as information and communication technologies.

The report presents the concept of decision-making support, operational accounting and investment information technology software.

The program includes the following:

- ❖ The actualization of the lists of issuers and holders of securities;
- ❖ Lists of securities issuance, registration, and its characteristics;
- ❖ Formation of optimal securities packages;
- ❖ Accounting of securities sold and purchased;
- ❖ Accounting for securities purchased and sold by the investor;
- ❖ Conducting an interest rate payment schedule for profit calculation;
- ❖ Conducting the nominal value amortization schedule;
- ❖ Conducting primary registration and regulated registry;
- ❖ Operational accounting, automated reporting of securities accruals;
- ❖ etc.

A MIX NETWORK WITH PARALLEL STRUCTURE AND MULTIVARIATE POISSON INPUT FLOWS

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Our network of queues is a collection of service centers (nodes) $E_0, E_1, \dots, E_r$, which represent multichannel systems. The node E_0 operates as a queuing system of the type $M/M/\infty$, thus the service time of the each customer is exponentially distributed with the parameter $\mu > 0$. The nodes $E_1, E_2, \dots, E_r$ operate as Jackson's network of the type $[M/G/\infty]^r$. Denote $G_i(t)$ the distribution function of service time in the node E_i , $i = 1, \dots, r$. Let us consider a set of the bivariate Poisson input flows $(\nu_1^i(t), \nu_2^i(t))$ $i = 1, \dots, r$ with the parameters $\lambda_i = \theta p_i, i = 0, r; b_i, i = 1, r; \sum_{i=1}^r p_i = 1$. Suppose as well $X_i(t)$, $i = 0, 1, \dots, r$ is the number of customers in the node E_i , $P = \|p_{ij}\|_{i,j=1}^r$ is a transition matrix. Let's consider the generation function $\Psi(z, t) = \sum_{k_0, k_1, \dots, k_r} z_0^{k_0} z_1^{k_1} \dots z_r^{k_r} \times P\{X(t) = (k_0, k_1, \dots, k_r)\}$.

Theorem 1. Let the queuing network meets following conditions:

$$1) \text{ exist } i, \text{ that } \sum_{j=1}^r p_{ij} < 1 \quad 2) \quad a_i = \left[\int_0^{+\infty} t dG_i(t) \right]^{-1} \neq 0.$$

$$\text{Then } \lim_{t \rightarrow +\infty} \Psi(z, t) = \exp \left\{ - \left(\frac{\lambda_0}{\mu} + \frac{1}{\mu} \sum_{i=1}^r b_i - \langle bP^*(\mu), 1 \rangle (1 - z_0) - \right. \right. \\ \left. \left. - \langle (\alpha^{(1)} + \alpha^{(2)}) D^{-1}(a) - bP^*(\mu), 1 - z \rangle - \langle bP^*(\mu), 1 - z_0 z \rangle \right\},$$

$$P^*(\mu) = (I - Q^*(\mu))^{-1} D \left(\vec{G}^*(\mu) \right), \quad Q^*(\mu) = \int_0^{+\infty} e^{-\mu u} dQ(u), \quad \alpha^{(1)} \text{ is the}$$

solution of the equation $\alpha^{(1)}(I - P) = \lambda$ and $\alpha^{(2)}$ is the solution of the equation $\alpha^{(2)}(I - P) = b$, $b = (b_1, \dots, b_r)$.

USE OF POLYAROMATIC HYDROCARBONS TO IDENTIFY SOURCES OF CONTAMINANTS

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There are numerous polyaromatic hydrocarbons in our environment. One of the most common and simplest is naphthalene, that consists of two benzene rings. Other common PAHs are anthracene, which has 3 rings, and pyrene which has 4 rings. Some forty different congeners of PAHS are often quantified in an analysis. Different sources of contamination have different levels of PAH concentrations, this provides a signature. Two sources are petrogenic (e.g. coal) or pyrogenic (e.g. diesel exhausts).

The PAHs are typically very stable (those extracted from coal have been there for millions of years), they have very low solubility in water but are soluble in organic matter. There is an equilibrium partition of PAH in sediment governed by

Where there is a moderate amount of coal in the sediment that provides both the source of the PAH and the source of organic carbon, and the PAH of a particular concentration is known, the pore water concentration of the PAH is shown to be independent of the amount of coal in the system.

A useful technique in studying the PAH in sediment is to regress the concentration of the PAH congeners in a sediment sample against the PAH concentrations in coal believed to be associated with the sediment. The R^2 of the fit gives a measure of the faithfulness of the coal to the contamination in the sediment, whereas the slope of the regression (limited to the range 0 – 1) gives an assessment of the amount of contamination. Challenges in fitting the regression will be presented.

USING INFORMATION-COMMUNICATIVE TECHNOLOGIES (ICT) IN FOREIGN LANGUAGE TEACHING PROCESS

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Nowadays searching for effective IT teaching methods is becoming very actual in a sphere of education.

Today gives foreign language teaching process not only the communicative function, but bigger responsible new international requirements, such as implementation of trade cooperation, business relations, political and other international issue solutions between countries.

In order to create a motivation for foreign language communication in learning environment it is necessary that we create some kind of action situation, i.e. we should use such circumstances, where the language learner will be placed and will have to interfere in a conversation. Thus, artificially created action situation has to cause the need to talk in a language learner. The research of such action situation creation and scientific approach is a strong basis of foreign language effective teaching.

Using today's IC technologies of level and quality was preceded by many scientific studies, that was the foundation of its development and up-to-date existence. However, modern IC technologies are not the final version and need to be upgraded.

The aim of the report is to show the necessity of digital application integration in a learning course in order to develop particular language confidence, also to review possible risks and results while using digital resources.

ON THE ROLE OF INFORMATION TECNOLOGIES IN THE DECISION-MAKING PROCESS IN DEALINGS

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The present scientific paper outlines decision making as one of the most significant and important activities in a business. Decision making involves various processes which are influenced by technology. Information Technology provides a business with a Decision support system and Artificial intelligence system, the combination of these Information Technologies systems helps us create information through online analytical process to facilitate decision making tasks that might require significant effort and analysis.

Some academic and business decisions are easy to make than others, the process of making a decision involves intelligence, design, choice and implementation. When making a decision all these four aspects must be put into consideration.

Design: Find and fix issues. It's a stage of considering possible ways of solving the problem, filling the need, or taking advantage of the opportunity. In this phase, you develop all possible solutions you can.

The paper tells us on another way to vie decisions is by frequency with which the decision has to be made. The decision as to which job to take is the sort of decision you don't make on a regular basis – this is a nonrecurring decision. Yet on the other hand, determining pay for hourly employees is a routine decision making those businesses faces periodically, so this becomes a recurring decision. A business can use technological tools like accounting software to calculate recurring decisions. For example, if a business relation has to pay its employees on an hourly basis, it can use accounting software to calculate the total number of hours for each employee and multiply that number with how much they're supposed to earn. This process becomes simple especially when the business has so many employees.

The paper discusses, that Data Processing Capabilities: technology will help you make quick business decisions by giving you the ability to slice and dice your way through massive amounts of information.

OPTIMUM DISTRIBUTION FACTORS FOR EDUCATIONAL PROGRAMS CREDITS

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The distribution of credits among different educational components should be based on the real possibilities of a student in the field of study and should be considered for a student with medium academic achievement.

This requirement, of course, is not provided for formal processes, but to achieve specific set learning outcomes for each component. Obviously, this is not an easily calculated and evaluated process, therefore, to compile the correct credit distribution management and determine the optimal student workload, it is necessary to conduct a scientific analysis of all the necessary information. In addition, scientific analysis should not be one-sided, the experienced professors, teachers, practitioners and students should be invited as experts. Only in this case the desired results will be achieved.

Credits should not be distributed only according to the contact hours. The distribution of credits means the time spent by a student on the audience, lectures and seminars, as well as independent work, homework, preparation for exams, etc.

As is known, the annual workload of a student is 60 credits, adapted to the European credit system. This means that a student must collect 60 European credits during the year. Based on this amount of annual workload, it is easy to calculate how many working hours are compatible with 1 credit. For this, the number of hours should be divided into 60 credits; we get that one European credit consists of 22.5 academic hours of study activity (workload) of a student. In practice, in our institutions of higher education this number is observed and varies from 25 to 27 hours.

If we do not take into account the concept of managing the optimal distribution of credits, the number that is different from annual 60 credits will create a problem for the student during mobility, and various credits received by him will not be recognized in foreign institutions of higher education.

The present paper deals with all the above issues.

ANALYSIS OF THE WORK OF CONWAY CELLULAR AUTOMATION MACHINE

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The cellular automaton algorithm, invented by the British mathematician John Conway, was used to predict agricultural development in the suburbs of Toronto, the territory of which was divided into parts and environmental factors, such as roads, terrains.

The game created by Conway illustrates how different living systems can survive in some specific environments, in terms of decreasing entropy. The game and its other versions with different rules are known as cellular automaton machines, which comprise a number of experiments and research bases in Computational Biology.

Informational entropy is also called the Shannon entropy. According to the theory by Shannon, entropy is the limit of uncertainty, otherwise, it can be called the limit of chaos. Simply put, the Shannonian entropy is a function of determining the amount of information in a system. To refer to the term entropy, the term Shannon information or amount of information on a Shannon formula is often used.

Conway's world itself represents the graphic form of a binary code (in a sense, it is a message). Therefore, we can subordinate entropy to the given binary array. Also, in turn, each cell has 8 neighbors (which influence each other), and in the same way, we can subordinate a certain entropy to them.

The goal of our research is to link Conway's "life game" and entropy together.

To this end, the program, the working area of which is divided into two parts, has been written in C #: the first part is a simulation of Conway's world, and the second part is a visualization, a connection of this world with entropy.

Within the framework of this program, several experiments have been conducted; they showed that entropy and especially lowered entropy have a great influence on the functioning of such discrete systems.

BASICS OF DETERMINING THE KEY FACTORS OF THE TASK OF FORECASTING THE DEMAND-PROVISION FOR SPECIALISTS

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The era of information technology has completely changed existing methods, and, consequently, the today reality requires a review of existing approaches and forecasting methods, their conformity with the laws of a market economy, as well as adapting the tasks of forecasting a demand for qualified personnel in the education system. All of the above is associated with dynamic changes in quantitative and qualitative indicators of specialists.

Objective difficulties have arisen in determining the priority and prospects of employment in a socially oriented market economy, in developing demand-supply strategies for specialists, in the preparation of socio-economic development programs for the region and the development of a conceptual model of employment in these programs.

The long-term plan for the development of intensive forms of professional training should be preceded by a forecasting process. Proper forecasting requires studying the directions of development of the regional economy, identifying the main factors affecting it, and creating prerequisites for making decisions. A policy of the economic concept of the regional development will be developed, taking into account the impact factors and directions of development of the regional economy. Correspondingly, there will be defined the tasks of forecasting the provision of highly qualified specialists, necessary for the implementation of this policy.

The study and systematization of the labor market is based on the determination of various socio-economic, demographic, organizational-technical, cultural-traditional, etc. factors and indicators.

The present paper deals with all the above issues.

SELECTION OF THE DESIRABLE OPTION FROM THE RANGE OF ALTERNATIVES DURING TRANSPORT OPERATIONS

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Our objective is to select desirable option from the range of alternatives (in our case option from loading/unloading operations), i.e. to take such decision which will be the best (optimal). Classification in this case is the basis, as at this time the selection is based on the variety of a class that can be assigned to alternatives. Stratification and ranking give us wide opportunity to make targeted selection, i.e. the decision to be optimal for a given moment and event.

During transport operations, we choose one out of several options for selection of traversal because it is impossible to use different traversal for the same marine transport means at the same time. Also, we choose one out of the most optimal options from different schemes of loading-unloading operations on the vessel because in this case, it is impossible to realize several schemes simultaneously.

Optimal selection of loading/unloading operations on the vessel should be selected from the range of alternatives used by any method. We consider to use the most advantageous linear and integer programming methods.

Linear and integer programming methods Using the simultaneous use of linear and integer programming methods, it is possible to develop a number of algorithms that can be used as optimal alternatives, taking into consideration all their characteristics and specifications, and interactive research of specific options chosen from these alternatives, to get more profitable and favorable scheme for different types of cargo transportations.

At the initial stage, all possible possible combinations of production of load-unloading operation will be modeled and of course the marine transport (in our case of the vessel) on the permissible route and vessel.

We focus on these issues in the above-mentioned article.

HIERARCHIC CLUSTERING OF UKRAINE'S REGIONS BY THE CONDITIONS OF SMALL BUSINESS DEVELOPMENT

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The regions of Ukraine are very heterogeneous in terms of economic development, demographic characteristics of the population, infrastructure and so on. These differences are caused by the geographical features of the areas, historical factors, the mentality of the people who live there. Small business conditions are also not the same in different regions of Ukraine.

The purpose of this paper is to highlight these regional peculiarities and to unite the regions of Ukraine into groups with similar characteristics of small business development. For this purpose, we collected the statistics about fourteen features that characterize the status and prospects of doing business in the regions of Ukraine.

To differentiate the regions of Ukraine, cluster analysis was applied, namely the agglomerative procedure, the essence of which is that each region in the first step is a separate cluster, and at each subsequent step the two clusters (which are the nearest in Euclidean distance) are united together in one [1]. The distance between clusters was calculated on the basis of the principles of single connection (when the distance between clusters is defined as the minimum distance between objects from different classes), full connection (when the distance between clusters is defined as the maximum distance between objects from different classes) and medium connection (when the distance between clusters is defined as the distance between the centers of gravity of these clusters). The corresponding dendrograms illustrate these step by step clustering. The analysis gives an opportunity to develop effective ways of solving current problems for each group of regions, taking into account their specificities and potential. Issues related to the activity, development, problems and prospects of small business are important and extremely relevant to Ukraine in the current period.

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QUADRATURE-DIFFERENCE METHOD FOR SOLVING CAUCHY PROBLEM WITH HYPERSINGULAR INTEGRAL ON THE RIGHT SIDE

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The study of many dynamic processes is reduced to problems with a free boundary of the region [1]. A dynamic problem can be formulated as a Cauchy problem to determine the evolution of a free boundary. The report discusses the problem, which is that the equation (or system of equations), which determine the dynamics of the boundaries, have an integral representation on the right side, with a strongly singular core. So, in complex form:

$$\left\{ \begin{array}{l} z = \omega_v(t) \in L_v(t), \quad t > t_0 : \\ \frac{d\bar{\omega}_v(t)}{dt} = \frac{1}{2\pi i} \int_{L_v} \frac{f(\omega, t) d\omega}{(\omega_v - \omega)^n}, \\ n = 1, 2, 3, \dots \\ \omega(t_0) = \omega_0 \in L_v(t_0) \end{array} \right.$$

In the case when $n=1$, the equation turns into the Birkhoff-Rott equation, it has an integral expression with a Cauchy-type singularity on the right side. The report presents approaches to constructing quadrature-difference schemes for numerically solving the above Cauchy problem, the equation of which has different types of singularities on the right side (for different values of the indicator). It is shown that in order to determine the approximation, stability, convergence, and accuracy of numerical methods, it is important to correctly calculate the principal value of the integral representations when constructing quadrature-retinuous schemes.

The evidence presented in the report makes it possible to use the discrete singularity method (DSM-method for solving singular / hypersingular integral equations [1]) for constructing universal computing technologies, the computer implementation of which provides simulation of dynamic processes in real time. It will demonstrated advantages and limitations of using DSM for evolution problems.

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ESTIMATION PROBLEMS FOR RANDOM FIELDS FROM OBSERVATIONS ON SERPINSKI 'S CARPET

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Problems of estimation of the unknown values of random fields are generalization of problems of extrapolation, interpolation and filtering of stochastic processes. Such problems arise when we are finding solutions to important problems in geophysics, automatic control, etc. Methods of solution of linear estimation problems for random fields, where region of observation was represented as a bounded area or perforated rectangle were developed in [3], [4].

In this paper we deal with the problem of estimation of the unknown values of a mean-square continuous homogeneous random field $\xi(t, s)$ from observations of the field $\xi(k, j) + \eta(k, j)$ in all points $K \subset D$ where K represents plane fractal called the Serpinski's carpet [2].

The problem is to find the optimal estimation of the linear functional $A_K \xi$ of unknown values of the field $\xi(k, j)$, $(k, j) \in K$ from observations of the sum $\xi(k, j) + \eta(k, j)$, where K represent Serpinski's carpet [1]:

$$(k, j) \in Z^2 \setminus K, \quad K = \left(\frac{3}{2} - 3 \left| k_n - \frac{1}{2} \right|, \frac{3}{2} - 3 \left| j_n - \frac{1}{2} \right| \right).$$

So, we need to find a value $\tilde{A}_K \xi$ inside the class of linear functionals, which minimizes the value of the mean square error [3]:

$$\Delta = M |A_K \xi - \hat{A}_K \xi|^2 \rightarrow \min.$$

To solve this problem, we use the classical method of projections in the Hilbert space in case when the spectral densities are exactly known [3]. The spectral characteristic of the functional optimal estimator and the value of the mean-square error and the dependence of the obtained formulas on the geometry are found.

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THE OPTIMAL BLOCK SEARCH IN THE CASE OF THE GENERALIZED DISTRIBUTION OF PROBABILITIES OF ACCESS TO RECORDS

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A one-level block search for records in an ordered file is considered. The file contains N records broken down into n blocks by $m = 2^l - 1$ records in each block, where l is an integer ($l \geq 2$). In [1], the effectiveness of this search method for different laws of distribution of the probability of accessing records (uniform, binary, Zipf, generalized [2]) was investigated when using the sequential view method in a block. Block search method can be greatly improved by using the binary search method in a localized block.

Using the formula of mathematical expectation of the number of comparisons in the binary search method in the case of different laws of unequal distribution of the probabilities of accessing records [1]

$$E = \sum_{i=1}^l \sum_{k=1}^{2^{i-1}} i p_{(2k-1)n_i},$$

where p_i – is the probability of accessing to the i -th record of the file, $n_i = 2^{l-i}$, we find that in the case of a generalized law of probability distribution and use in the localized block of the binary search method, the mathematical expectation of the number of comparisons required to search the record in a file is expressed by the formula

$$E = \sum_{j=1}^n \sum_{i=1}^l \sum_{k=1}^{2^{i-1}} ((j-1)(2^l - 1) + i) p_{(j-1)(2^l - 1) + (2k-1)n_i},$$

where $p_i = \frac{1}{i^c H_N^{(c)}}$, $i = 1, 2, \dots, N$, $H_N^{(c)} = \sum_{k=1}^N \frac{1}{k^c}$ – a partial sum of the generalized harmonic series, $0 < c \leq 1$.

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SPACE WEATHER PREDICTION USING NEURAL NETWORKS: A TOOL FOR INFORMATION ASSESSMENT AND DECISION MAKING

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The smooth functioning of the Ukrainian economy and the welfare of its citizens depends upon an ever-growing set of services and facilities that are reliant on space and ground based infrastructure. Examples include communications: (radio, TV, mobile phones), navigation of aircraft and private transport via GPS, and service industries (e.g. banking).

These services, however, can be adversely affected by the space weather hazards. The forecasting of space weather hazards, driven by the dynamical processes originating on the sun, is critical to the mitigation of their negative effects.

This proposal brings a leading groups in the fields of space physics, computer science and systems science in order to develop:

- ✓ an accurate and reliable forecast system based on neural networks for space weather. It combines their individual strengths to significantly;
- ✓ improve the current modelling capabilities within Ukraine and to produce a set of forecast tools to accurately predict
- ✓ the occurrence and severity of space weather events. We will develop a tool to forecast the solar wind parameters just upstream of the Earth's magnetosphere.
- ✓ we will develop a comprehensive set of forecasting tools for geomagnetic indices. We will combine the most accurate data based forecast of electron fluxes at GEO with the most comprehensive NARMAX model of the radiation belts

currently available to deliver a reliable forecast of radiation environment in the radiation belts.

- ✓ Our research will deliver these individual forecast tools together with a unified tool that combines the forecasting tools.

APPLICATION OF METHODS OF MULTIPLE FACTOR ANALYSIS FOR RESEARCH OF SOCIO-ECONOMIC PROCESSES

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Analysis of variance is applicable in all fields of research, where it is necessary to analyze the impact of various factors on variable under study.

The main method for research has become analysis of variance, which is a powerful modern statistical method of processing and analysis of experimental data in psychology, medicine and other sciences. It is very closely linked to a specific methodology for planning and conducting experimental studies.

The purpose of this work is to find the connection between the components of the social component of human life.

These links can be shown using the basic ANOVA:

$$Q = Q_1 + Q_2 = B - C - B + A = A - C,$$

Where $A = \sum(\sum(x_k)^2)$, $B = \sum[(\sum x_k)^2 * \frac{1}{n_k}]$, $C = \frac{(X^*)^2}{n}$,

$$X^* = \sum(\sum x_k), n = \sum n_k.$$

It's part x_k – data sampling, n_k – the number of items in the sample.

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FUNCTIONAL LIMIT THEOREMS FOR GALTON-WATSON PROCESSES WITH VERY ACTIVE IMMIGRATION

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I am going to discuss weak convergence in the Skorokhod space of Galton-Watson processes with immigration, properly normalized, under the assumption that the tail of the immigration distribution has a logarithmic decay. It will be explained that the limits are extremal shot noise processes. Interestingly, both the behavior in mean and the survival probability (especially in the subcritical case) of the underlying Galton-Watson processes without immigration affect the asymptotics in question.

The talk is based on the recent article [1].

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ABOUT HYBRID DIFFUSION MODELS OF INFORMATION DISSEMINATION PROCESSES AND THEIR APPLICATION

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One of the scientific areas, which has been given serious scientific attention recently, is mathematical modeling, the main purpose of which is to obtain the possibility of studying the processes of the functioning of quantitative and qualitative characteristics of a real object or system [1].

In this abstract the research of problems of modelling of information dissemination and influence processes on the basis of application of multidimensional and hybrid dynamical models of diffusion type is conducted.

An overview of approaches and methods of formalization of dynamic processes based on the use of analogies is given. The contents of the problem of mathematical modeling are described in detail, the description of the main classes of dynamics models is given. The

principle of analogies in the construction of mathematical models is formulated, examples of real dynamic processes are presented, in which the methodology of analogies is used. The problems of formalization of processes of distribution of diseases, processes of kinetics of enzymatic reactions, transitional economic processes and the process of functioning of a network of neuroformed elements are considered. It is proposed to apply the considered models to study the processes of information dissemination and influence on the society.

The approach to construction of hybrid mathematical models of the dynamics of dissemination of information processes in the target groups of the population is proposed. The basis of formalization is the use of homogeneous and heterogeneous models of the process of diffusion (penetration) of information in the network. Examples of practical application of developed models and methods for solving tasks of dynamics of information processes are given. The results allow us to talk about the adequacy of using hybrid models.

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APPROXIMATE GUARANTEED MEAN-SQUARE ESTIMATES OF PARABOLIC EQUATIONS WITH FAST OSCILLATING COEFFICIENTS

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In this paper, we focus on the problem of minimax estimation of a functional on the solution of parabolic problem with rapidly oscillating coefficients. To solve this problem, the traditional minimax approach is used because of the presence of unknown functions on the right side of the equation and in the initial condition. First, we prove the existence of a guaranteed linear mean square estimate of the original problem. However, it forces us to look for an approximate solution of the original problem using the averaging theory and the approximate synthesis methods for distributed systems because of the nonlinearity of the observation operator (that is, the operator of the superposition type) and

the presence of rapidly oscillating coefficients. The main result of the work is to prove that the estimation of the problem with averaged parameters is an approximate guaranteed mean square estimation of the original problem.

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THE ROLE OF DEVELOPING SYSTEMIC THINKING IN DECISION MAKING PROCESS AT THE ELEMENTARY LEVEL OF TEACHING

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In the conditions of modern civilization, it is necessary modeling an adequate educational process for this civilization. It has to play a new role through its clear tasks and results, which are reflected primarily in human's lives and in the qualified professional activities.

In order to achieve this, it is important to form a society-mind, fast-paced processes and related changes in the fast-paced world.

We mean the basic requirements for thinking that are primarily manifested in the processing of information which purpose is to solve problems, make logical conclusions, and facilitate decision-making in uncertainty. It is a cognitive process that takes place in the human mind, at this time knowledge is used to manipulate it according to the created situation and all this is revealed in its behavior.

The report discusses the use of modern methods and methods of systematic thinking formation at the elementary level of teaching. Of course, this is very important. It promotes the ability to make decisions in conditions of uncertainty.

In this case, the continuity of the education process, from the elementary level, is of paramount importance. Still, today there is a tendency to think in terms of narrow specialization. This prevents the

formation of systemic thinking. If we look at and analyze the atlas of the future professions in line with the demand for market economy, the analysis will lead to the necessity of making substantial changes in the modern education system. This evidence stems from the need for a thinking society and intellectual capacity to face the future processes. The high rates of modern life and the multifaceted direction and rapid changes in the labor market are deciding issue, problem: People must constantly be able to improve their specialty, keep up with the innovative pace of community development; He must be ready for a drastic change in the profession, for mastering completely new technologies, manufacturing processes and etc.

The attempt to solve all of the above is an introduction to the subject of "System Engineering" in our school, which develops systematic thinking at an early age; Fosters the mentality of information and communication technologists as knowledge acquisition skills; Develops distance education skills. A brief description of this issue and the introduction of a new type of educational activity allow us to conclude that such changes are promising and contribute to the resolution of community-based educational processes.

DESIGN DECISION MAKING IN THE PROCESS OF CREATING A USER INTERFACE

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Creating a graphical user interface is an area of interdisciplinary activity. It cannot be created by one person and requires the involvement of a multifunctional team in the design process. In this case, multifaceted knowledge is realized, which ensures the multi-functionality of the interface. The design team that makes a joint design project is an expert team with a graphic artist, system designer, analyst, programmer, modeler, technology expert, psychologist and possibly qualified specialists, based on the local interface specification.

The initial stage of designing a user interface is to analyze the requirements for it, on the basis of which a group of experts (designers) makes the appropriate design decision, the product of which are possible scenarios of system operation, precedent descriptions, and prototyping, and most importantly, modern object-oriented software applications.

The main point of the problem is that in most cases, when designing modern user interfaces, the decision-making process violates the principle of systematicity and a number of issues are not provided. Based on our analysis we have determined the content of these issues, which we must pay attention to: system interface elements should be processed; An alphabet of interaction that will make learning easier for customers; Effective form of individual elements and element groups; Develop a conceptual design that takes into account the psychological aspects of the user.

Research on modern user interfaces has shown that interfaces are seen as the subject matter itself, and not as a user experience for us, this is why sometimes users refuse to work with the system, which may cause some applications to fail. And those programs and websites that provide psychological comfort to the user and create a simple and conditional environment for them to function successfully.

We need to outline another important principle of interface design. It is about balancing the interactive capability of the program and the complexity of the delivery mechanisms to its users. In particular, the adequacy of the program's functional capabilities, its ability to manipulate and design. In today's user interfaces this problem must be corrected. Difficult interface users are psychologically aware that they are dealing with a complex program(it is not about a professional interface). Therefore, the "acquaintance" stages of the interface should be taken into account, when he gradually reveals his abilities. The following issues are added to "Interface Physics". Synchronize user attention and system activity points. This problem must be solved in a complex way. On the one hand, the user must be able to tell the system where and what he wants to change, and on the other hand, the system must be able to draw the user's attention to the area where changes are most active.

We should pay special attention to the animation interface. In the graphical interface, the user is dealing with a sequence of drawings. Programmers usually pay attention to the time between drawings (speed). Psychologists' approach is pragmatic - what time does the average user spend on getting to know new graphical data and getting in touch with it? This time interval not only includes the time the graphic is displayed on the screen, but also the period of time the user is aware of it. Applying the animation effect obviously increases the amount of time between alternating graphical data, but their perception and cognition time is substantially reduced. There is another feature of the

animated interface that makes it even more appealing. These are dynamic visual signals that represent a change of image on the screen, which is intended to provide additional information to the user (Ex. Sand clock “Mouse”). When creating an animated interface, the system of dynamic visual signals must be processed from the beginning, as these signals are a necessary organic part of the interface.

Given the above, the decision to create a user-friendly interface poses a difficult task to programmers and designers. The report discusses widely the ways of solving these problems.

DECIDING ON THE PROCESS OF CHOOSING MULTIMEDIA SYSTEMS FOR DEMONSTRATING TEACHING MATERIALS

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Modern ICTs and the Internet create unlimited opportunities to access e-learning resources, enrich and make lectures / lessons with interactive computer programs and multimedia materials, share with others and gain their own learning experience, enhance their professional experience Knowledge and become more qualified education worker.

Creating a positive emotional environment is especially important for the learning process. This can be achieved by incorporating elements of business or didactic game learning. This is especially important at the elementary level of teaching. However, it does not lose its priority at any level of teaching. Didactic games develop student/pupil learning, problem solving, and creative thinking skills, while giving the teacher the advantage of tailoring learning resources. Computer games are kind of virtual lab where a student becomes a researcher and learns actively. These fun games have a sequence of teaching materials, are consistent with the subject material of the curriculum, and are an auxiliary supplement to better understand the subjects. Each stage of the game is loaded with new interactive animations and puzzles, fun tasks.

The inclusion of such technologies in the curriculum represents an innovative approach that can be presented as an innovative guideline.

It should be noted that the decision-making process for choosing one or more multimedia solutions is very problematic as the selection process takes place under uncertainties.

The uncertainty condition is caused by many factors.

One of these factors is the variety of the electronic "Innovation Handbook", its versatility and the complexity of forming an alternative set of teachers.

In decision-making we consider it necessary to prioritize the following parametric characteristics of the qualifying multimedia system: training and controlling; Mentorship; Imitation and modeling; Developer. Taking into account these parameters, we have selected a multimedia innovative textbook, which is actively used in Kutaishi primary school - "Gone Qveynisa" activities. The "Innovation Guide" is very easy and effective to use, following the sequence of use:

Download the app **Fun Study** to your computer or mobile phone

1. Computer and mobile data must meet the requirements for program performance (Android 2.3 version or IOS 5 and next);
2. To use a downloaded application, you first need to select a theme that matches the marker. The marker is separated by special marks and the "eye" mark. Sometimes the marker (picture) is not activated immediately, in which case you need to move the camera to the page and then redirect to the drawing. While scanning, both the marker and the objects near it may appear on the screen. It depends on the position of the camera and the object (picture).

You should contact the Authorized Representatives of its distributor - Fun Study to find out this innovative guide.

VISUALIZATION OF BEAM DYNAMICS AND USING NON-DIFFERENTIATED OPTIMIZATION METHODS

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The problems' statement analysis of trajectory ensembles and correspondent mathematical models describing ion beams' dynamics optimal control that had been performed by authors during the last thirty years showed that their constructive solution requires new investigations in the domain of stability and optimization.

Engineering of charged particles' accelerators is well designed on the basis of physical principles of acceleration and focusing. But now the

following tasks are urgent: phase volume of beam maximization on input and minimization of ion beam parameters spread on output.

Work studies mathematical models of longitudinal and radial motion of charged particles in linear accelerators, use and modification of non-differentiated optimization methods to solve tasks with minimax quality criteria, to create software, to perform optimization procedures and to carry out computing experiment by means of visualization.

To study effectiveness of such optimization methods, special software was developed giving possibility to visualize dynamics of charged particles in linear accelerator and to perform optimization procedures.

It was also proved that the task of charged particles' beam control is closely related with the problems of motion stability theory. The unique method of trajectory optimization tasks' solution was created for mathematical models of real linear accelerators of charged particles. Based on the methods of structure and parameter optimization tasks' solutions for non-differentiated optimization problems were founded.

ASYMPTOTIC DISSIPATIVITY OF THE SYSTEM OF VIRUS MULTIPLICATION IN A POPULATION OF MARINE BACTERIA

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Considering the system of differential equations which describes the virus multiplication in a population of marine bacteria [1]

$$\begin{cases} \frac{ds(t)}{dt} = \alpha s(t)(1 - (s(t) + i(t))) - KCs(t)p(t) \\ \frac{di(t)}{dt} = KCs(t)p(t) - \lambda i(t) \\ \frac{dp(t)}{dt} = -KCs(t)p(t) - \mu p(t) + (b + x(t))\lambda i(t), \end{cases} \quad (1)$$

where $s(t)$ – normalized concentration of bacteria, $i(t)$ – normalized concentration of infected bacteria, $p(t)$ – normalized concentration of

virus and $x(t)$ – ergodic Markov process determined in the phase space of states $\{-0.01, 0.01\}$ with stationary distribution $\{0.5, 0.5\}$.

In addition, we consider the case when an independent external factor in the form of a diffusion perturbed term $\sigma(s, i, p)dw(t)$ also affects the change in the concentration of virus. Here $\sigma(s, i, p)$ – diffusion, a $w(t)$ – Wiener process. Therefore, system (1) takes form

$$\begin{cases} \frac{ds(t)}{dt} = \alpha s(t)(1 - (s(t) + i(t))) - KCs(t)p(t) \\ \frac{di(t)}{dt} = KCs(t)p(t) - \lambda i(t) \\ \frac{dp(t)}{dt} = -KCs(t)p(t) - \mu p(t) + (b + x(t))\lambda i(t) + \sigma(s, i, p)dw(t). \end{cases} \quad (2)$$

System (2) is asymptotic dissipative if it converges to the limited system (1), which is dissipative. Conditions of dissipativity of the limited system are as follows [2,3]

$$\begin{pmatrix} \alpha s(t)(1 - (s(t) + i(t))) - KCs(t)p(t) \\ KCs(t)p(t) - \lambda i(t) \\ -KCs(t)p(t) - \mu p(t) + b\lambda i(t) \end{pmatrix}^T V'(s, i, p) < -A_1 V(s, i, p),$$

$$\sup_{(s, i, p) \in R^3} \|\sigma(s, i, p)\| < A_2,$$

where $A_k > 0, k = \overline{1, 2}$ and $V(s, i, p) \in C^3(R^3)$ Liapunov function of determined system [1]

$$\begin{cases} \frac{ds(t)}{dt} = \alpha s(t)(1 - (s(t) + i(t))) - KCs(t)p(t) \\ \frac{di(t)}{dt} = KCs(t)p(t) - \lambda i(t) \\ \frac{dp(t)}{dt} = -KCs(t)p(t) - \mu p(t) + b\lambda i(t). \end{cases}$$

The considered problem allows to study the behavior of the system in the presence of random perturbations of a different nature, in particular the effect on the coefficient of the generation of viruses [1] in the form of a Markov process, as well as the influence of an external factor in the form of a diffusion perturbed term. The asymptotic dissipativity of such a system will allow to analyze the evolution of changes in the number of viruses in an interval.

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GEOINFORMATION CARTOGRAPHIC MODELING OF WATER FLOWS IN PSEUDO-PRISMATIC CHANNELS WITH UNEVEN BOTTOM

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To find the dynamics of fluid flow changes in the prismatic channel [1], the finite element method is used, which approximates the change of the channel square and the velocity of water over time.

The initial-boundary problem of fluid motion in the prismatic channel is formulated as follows:

$$\frac{\partial(uf)}{\partial x} + \frac{\partial f}{\partial t} = 0, \quad (1)$$

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

$$u|_{t=0} = u_0(x), \quad f|_{t=0} = f_0(x), \quad x \in [0, L], \quad (3)$$

$$u(t, 0) = 0, \quad f(t, 0) = 0, \quad (4)$$

where u, f – unknown variable speeds and cross-sectional areas; $g = 9,8 \text{ m/s}^2$ - acceleration of gravity; $c=const$ - coefficient of Shezi; $i =$

$\sin \delta = \text{const}$ - inclination of the middle bottom line; $B = b_- + b_+ = \text{const}$ - width of free surface; $R = \text{const}$ - hydraulic radius of the channel.

For this model, initial-boundary and variational problems are formulated. The scheme of regularization of equations is constructed, which allows it to be used both for flat surfaces of the bottom of the channel, and for those in which the gradient of the slope changes rapidly.

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RESULTS OF OPTIMAL CONTROL OF UNSTEADY THERMOELECTRIC COOLING PROCESS UNDER UNCERTAINTY

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The process of unsteady thermoelectric cooling is described by a one-dimensional problem in parabolic equations with non-classical boundary conditions [1]. The solution of such problem specifies the dependence of temperature on coordinate and time in the legs of thermoelement. The coefficients of the parabolic equations are the properties of the n- and p-type legs materials, namely, the coefficients of the thermoEMF $\alpha_n(T)$, $\alpha_p(T)$, the resistivity $\rho_n(T)$, $\rho_p(T)$, and the thermal conductivity $\kappa_n(T)$, $\kappa_p(T)$, which are temperature dependent. The temperature dependence of these coefficients causes the nonlinearity of parabolic equations. At the same time, experimental determination of these temperature dependences is a rather complex physical task. They are measured on samples of thermoelectric materials with a certain error, that introduces an uncertainty into the coefficients α , ρ , κ of thermoelectric materials. Therefore, it is logical to consider optimization of the unsteady thermoelectric cooling process as a problem of optimal control under uncertainty and to consider the coefficients α , ρ , κ as temperature independent, but dependent on an uncertain parameter Θ , which is time independent. $\Theta \in G_\Theta$, $G_\Theta = [\Theta_{\min}, \Theta_{\max}]$, where $\Theta_{\min}$ and $\Theta_{\max}$ are the given constants. In this approach, parabolic equations will

be linear and can be written as follows:

$$\frac{\partial T_n}{\partial t} = a_n(\Theta) \frac{\partial^2 T_n}{\partial x^2} + b_n(\Theta) \frac{I(t)^2}{s_n^2}, \quad \frac{\partial T_p}{\partial t} = a_p(\Theta) \frac{\partial^2 T_p}{\partial x^2} + b_p(\Theta) \frac{I(t)^2}{s_p^2}, \quad (1)$$

where $a(\Theta) = \kappa(\Theta)/c(\Theta)$, $b(\Theta) = \rho(\Theta)/c(\Theta)$. The boundary conditions of the problem will also depend on the parameter Θ . $I(t)$ is a control function of the thermoelement supply current. $I(t) \in G_I$, $G_I = [I_{\min}, I_{\max}]$ for all $t \in [0, \theta]$. Under the uncertain parameter Θ , we consider the problem of determination the optimal control function $I_{opt}(t)$, which is independent of Θ and for which at the end time $t = \theta$ the cooling temperature $T_n(0, \theta)$ is minimal.

A method for solving optimal control problems in linear parabolic equations under uncertainty is proposed in [2]. To solve the problem, we set the functional dependences of the material properties on Θ in the form $\alpha(\Theta) = \bar{\alpha}\Theta$, $\rho(\Theta) = \bar{\rho}\Theta$, $\kappa(\Theta) = \bar{\kappa}\Theta$, where $\bar{\alpha}, \bar{\rho}, \bar{\kappa}$ are the values of the corresponding properties at a temperature $T = 300\text{K}$, as well as the uncertain parameter range $\Theta \in [\Theta_{\min}, \Theta_{\max}]$, where $\Theta_{\min}$ and $\Theta_{\max}$ are permissible minimum and maximum deviation of the property values from their value at $T = 300\text{K}$. An example of solving the problem is shown in Fig. 1, 2.

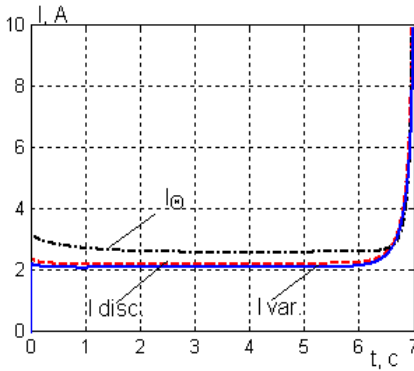


Fig. 1.

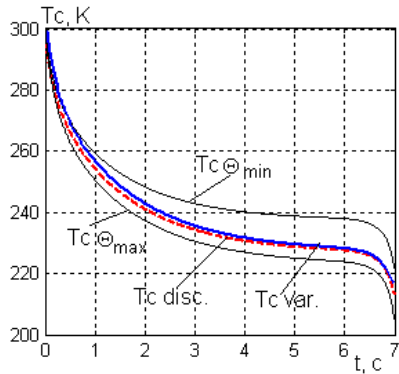


Fig.2.

The optimal function of the supply current $I_0(t)$ for the time interval $\theta=7\text{s}$ is shown in Fig. 1, and Fig. 2 demonstrates the corresponding time dependences of the cooling temperature T_c calculated for $\Theta_{\min}$ and $\Theta_{\max}$.

The uncertain parameter range was considered to be $\Theta \in [0.9, 1.05]$. For comparison, these figures show similar dependences obtained by the variation method and the coordinate discretization method for solving the problem, taking into account the temperature dependence of the thermoelectric material properties. Comparing the results shows that they correlate well with each other.

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STATISTICAL ANALYSIS OF THE TEMPERATURE STABILITY OF REFERENCE TIME INTERVAL OF THE SYSTEM OF PRECISE TIME STAMPS MONITORING

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To increase an efficiency of the modern integrated power supply systems, it is necessary to improve the tools for creating precise time stamps that are used for continuous monitoring of the power systems' parameters in accordance with the Smart Grid concept [1]. To insure a required monitoring reliability, first of all, it is necessary to determine a state of the time stamps signal – its presence or absence. The elimination of this uncertainty and decision-making is provided by the usage of periodicity control units (PCU) [2]. A decision is made on the basis of an analysis of the measurement data of synchronization signal and comparison results in the PCU of a duration of its clock interval and sample time interval, which is formed by the integrating RC-link [2].

The PCU, which is developed on the basis of 74HC123 microcircuit with RC-link, consists of a large number of electrical components, each of which affects the temperature stability τ - that is transient process duration (TPD) of the reference time interval.

To analyze temperature instability of the PCU, it is necessary to have characteristics of its each element in the form of an average value (mathematical expectation $M(\Delta\tau_1)$ and variance $D(\Delta\tau_1)$) of $\Delta\tau_1$ that is a deviation of the TPD with a temperature change of 1°C. A stability of the TPD, when external temperature conditions change, can be increased by introducing temperature compensation [3]. In the case of a linear temperature dependence of the parameters of electrical components and their absolute identity, an estimate of the effect of temperature compensation on the instability of TPD of a whole set can be made based on its single sample. In the case of non-identical temperature characteristics of PCU, we can talk about compensation of only the average values of the temperature coefficient of duration (TCD) or average values of $\Delta\tau_1 = \tau \cdot TCD$. Compensation can only reduce or make zero only an average value of temperature instability of the TPD:

$$M(\Delta\tau_t) = \tau \cdot M(TCD) \cdot M(\Delta t) = M(\Delta\tau_1) \cdot M(\Delta t) \quad (1)$$

and a variance of temperature instability of the TPD

$$D(\Delta\tau_t) = D(\Delta\tau_1) \cdot [M^2(\Delta t) + D(\Delta t)] + M^2(\Delta\tau_1) \cdot D(\Delta t). \quad (2)$$

At any reduction of $M(\Delta\tau_1)$ will always remain greater than zero. Equations (1) and (2) indicate $M(TCD)$ and $M(\Delta t)$ – a mathematical expectation of TCD and temperature change, respectively; $D(\Delta t)$ – a variance of temperature change.

We performed statistical analysis and established the requirements for the accuracy of temperature characteristics of the electrical components of PCU, which ensure a compensation of the average values of $\Delta\tau_1$ and give the best temperature stability of the TPD of PCU under the specified operating conditions of the monitoring system of the precise time stamps.

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DECISION MAKING IN MUNICIPAL MANAGEMENT

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Municipal administration decision-making has its specific characteristics in the management process. This is due to the fact that the manager or management unit (municipality) has powers that must be in line with public authority. This provision is true because the community is the most important resource for municipal decision-making and management.

Each planned work of the municipal administration is divided into three major functions:

- Legal decision-making;
- Enforcement of legal decisions;
- Analysis, control, correction of law enforcement.

Making a legal decision by a municipal administration is certainly a difficult process and requires:

- Analysis and evaluation of the situation at the management object;
- Forecasting;
- Planning.

Enforcement of legal decisions is the most responsible action in municipal management. It must provide a close link between management and governance. Therefore, it relates to the selection of best practice methods and methods from the defined actions and

associations. Only in this case will the targeted impact of the law be exercised to ensure the proper and efficient functioning of the municipal administration.

The determination of decision-making methods depends on a variety of factors and is mainly related to the behavior (nature) of the object and management objectives. For example, the main purpose of municipal management is to represent the integrated interests of the population; The collective interest here is expressed through the elected collegial body. No member of this body or their separate group has the right to request the opinion of all voters. Therefore, on behalf of the population, this body makes decisions collegially. However, we should not conclude that collegial decision-making is accompanied only by an elected representative body. Collegiality is a direct result of its nature, but the nature of the decisions it makes is also important. The representative body makes the decisions that are most important to the municipality. It is logical, that other decisions formulated by other bodies, as well as those of fundamental importance to the municipality, can be taken collegially.

The report broadly discusses the municipal management decision-making process that begins with the emergence of the problematic situation and ends with the choice of solution, action to eliminate the problematic situation. Management decisions are based on the following basic requirements: Timeliness; Thoroughness; Directive (compulsory enforcement); Adequacy; Purposefulness; Consistency and inconsistency (compliance with previous decisions); Competence.

STATIONARY REGIME FOR RETRIAL QUEUES WITH UNRELIABLE DEVICES

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In the study of a wide class of stochastic systems with retrial calls ([1]-[3]), it is necessary to calculate the characteristics of systems with infinite phase space. The Markov process describing the functioning of such a system has a countable set of states, and the matrix of intensity rates usually does not have any special properties that would facilitate its transformation in order to obtain an explicit solution.

We consider a queueing system with one server that is subject to active breakdowns. The time between retrials is exponentially distributed with known intensity $\lambda > 0$. Intensities of server breaking down ($\alpha > 0$), repair work ($\beta > 0$), service ($\mu > 0$) and retrial calls ($\theta > 0$) are known as well. When server breaks down the current customer leaves the server and becomes a new source of retrial calls. Primary arrivals, retrial calls, breakdown and service processes are mutually independent. The stochastic process $X(t) = (Q(t), A(t))$ describes the state of the system at time t ; where $Q(t) \in \{0, 1, 2, \dots\}$ is a number of retrial calls while $A(t) \in \{0, 1, 2\}$ describes the state of the server (0 – waiting, 1 – service, 2 – under repair).

The stationary distribution was obtained under mentioned conditions in general and one particular case. The stationary distribution existence conditions were derived similarly to standard algorithm (see [1]) while one more approach was considered too.

Later the obtained results will be applied to hysteresis strategies.

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ON SOME MULTI-CHANNEL NETWORKS WITH INPUT FLOWS OF GENERAL STRUCTURE

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We consider the model of a stochastic network with input flows of general structure arrived into each node. The node of such a network operates as a multi-channel queueing system with infinite number of servers. It means that a customer (or the call) which service is completed in a node is transferred to another node or it leaves the network with correspondent probabilities. Input flows into the different nodes can be

interdependent. Service times of customers are independent random values with exponential type distributions.

The multi-dimensional service process is introduced as the number of customers at network nodes. Processing of such a network under certain heavy traffic conditions is considered. Heavy traffic assumptions on network parameters are formulated. It is proved that in this case the multi-channel service process converges to a Gaussian process in the uniform topology. Correlation characteristics of the Gaussian process are written via network parameters in an explicit form.

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PRE-TRAINING BERT-MODEL ON UKRAINIAN CORPUSE

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In the recent years there have been numerous new models and methods in Natural Language Processing (NLP) that suggest completely new approaches to language modeling. In 2018, Google published its Bidirectional Encoder Representation from Transformers (BERT). This year, company named Open AI has published its GPT-2 language model and shows that text generated by a machine can be indistinguishable from that written by a human. These models are based on newest researches in the field of NLP and use concepts like Transformer, Attention, Encoder-Decoder architecture.

What makes BERT different from other recently published language models is the fact that it supports numerous languages, including Ukrainian. The first purpose of this research is to look at how well the BERT model is actually trained taking into account that Ukrainian language is a low-resource one. The second one is to create a hand-picked dataset to further train the published model and to compare the results of two models. Training the model in this research is based on texts written in Ukrainian, including fairytales, novels and stories for kids. This specific dataset is chosen mainly because of the fact that

stories for kids have not so big of a vocabulary considering its audience and the fact that those stories usually follow similar paths in their narration. Our model is trained on two tasks as in the original paper: masked token prediction and next sentence classification.

As a result, we have evidences that trained model can infer context from Ukrainian language much better than the original model does. The explanation for this fact is also given and some thoughts on potential ways to move further with the research in this domain are provided.

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ON METHODS OF A BEHAVIOUR ANALYSIS OF ECONOMIC SYSTEMS UNDER A PRESENCE OF INTERIOR SYSTEMATIC INFLUENCE FACTORS¹

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Equilibrium approaches describe a wide class of systems behaviour of different origins. One of such objects is an economic system under a presence of monopolies. The justification of an application of the equilibrium approach connects the game theory.

An equilibrium state is one of a possible state of the economy development. The knowledge of characteristics of equilibrium states of the economic system assists a selection of a preference scenario of an economy evolution.

The set of equations determine an equilibrium of the economy

$$\sum_{j=1}^l c_{kj}(p, \bar{D}) y_j = \Psi_k, \quad k = \overline{1, n}, \quad (1)$$

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$$\tilde{D}_j^1(p, x) + D_j = y_j \sum_{s=1}^n c_{sj}(p, \bar{D}) p_s, \quad j = \overline{1, l}. \quad (2)$$

Every solution of equations (1) – (2) is a set of values of characteristics of some equilibrium state. The values of variable $\{y_i\}_{i=1}^l$ indicate a measure of a quality of equilibrium states of the economy. The criterion of the quality is to a location in a defined values interval. The characteristics $\{\tilde{D}_i^1\}_{i=1}^l$ are gain functions or profit functions of system subjects. The variable values $\bar{D} = \{D_i\}_{i=1}^l$ mean an additional redistribution gain between system subjects. Only certain values $\{D_i\}_{i=1}^l$ lead to acceptable values $\{y_i\}_{i=1}^l$.

There is an algorithm of a determination of characteristics of acceptable equilibrium states with required properties. The algorithm includes an estimation of values limitations of variable characteristics.

HYSTERESIS STRATEGIES OF RETRIAL QUEUEING WITH ONE SERVER AND ONE PLACE IN THE QUEUE

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Retrial queueing systems are widely used in computer networks designing, in mobile and so on ([1],[2]). This paper deals with markovian retrial queues with unlimited number of repeated calls and controlled intensity of input flow.

Model under consideration can be described as follows. The system consists of one server. Service time has exponential distribution with parameter μ . When an arriving customer finds that server and place in the queue are busy, the customer joins a virtual «orbit» and repeat its request after a random time until the customers gets into the service area. Such attempts become a source of repeated calls. The input flow is represented by Poisson process which intensity λ depends on the number of repeated sources in the following way. Let $h_1 \leq h_2$ be two natural numbers which are called thresholds. If the number of repeated sources $j \leq h_1 - 1$, then $\lambda = \lambda_1(j)$ and if $j \geq h_2$, then $\lambda = \lambda_2(j)$. If $h_1 \leq j < h_2$ then the intensity of the Poisson process remains the same as

in the previous moment of time. If $h_1 < h_2$, such a system is called the system with hysteresis strategy, where as if $h_1 = h_2$ we say about system with thresholds strategy. The last systems were considered in [3].

For the model described the existence condition and explicit formulas for ergodic distribution of service process are obtained. These results essentially generalize the appropriate ones from [1] and they were used for solution of the optimization problem for the system with hysteresis strategy. The steady state profit was taken as a criterion function and the thresholds were treated as control parameters.

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PROBLEMS OF UNMANNED AIRCRAFT OPERATION SYSTEM INTEGRATION IN GEORGIAN AIRSPACE

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The decision making to allow integration of drones into Georgian civil space is associated to problems such as the threat to public services and the emergence of uncontrolled airspace.

In order to smoothly integrate drones into civil aviation, without being danger to State Services it is crucial to implement U-space step-by-step in uncontrolled airspace. U-Space is the term adopted for a set of services supporting low level drone operations (below 120 m). A fully automated infrastructure will provide the drone pilots with all the information needed to conduct a safe operation, including air traffic management, and will ensure that drones do not enter any restricted zones.

UA operations are classified in three risk-based categories:

1. **"open"** is a category of UA operation that, considering the risks involved, does not require a prior authorisation by the competent authority before the operation takes place;

2. **"specific"** is a category of UA operation that, considering the risks involved, requires an authorisation by the competent authority before the operation takes place and takes into account the mitigation measures identified in an operational risk assessment, except for certain standard scenarios where a declaration by the operator is sufficient;

3. **"certified"** is a category of UA operation that, considering the risks involved, requires the certification of the UA, a licensed remote pilot and an operator approved by the competent authority, in order to ensure an appropriate level of safety.

Only the "open" and "specific" operations are covered by the prototype regulation. The "open" category is further divided into four subcategories, based on technical requirements, operational limitations and requirements for the remote pilot or operator. The subcategories are:

- **subcategory A0:** operation of UA posing a negligible risk of severe injury to people on the ground or damage to manned aircraft, and requiring neither specific remote pilot competence nor age limitations;

- **subcategory A1:** operation of UA complying with requirements ensuring that they pose a negligible risk of severe injury to people on the ground or damage to manned aircraft, and requiring neither specific remote pilot competence nor strict operational limitations;

- **subcategory A2:** operation of UA complying with requirements ensuring that they pose a limited risk of severe injury to people on the ground or damage to manned aircraft, operated by registered operators, and equipped with geofencing and electronic identification;

- **subcategory A3:** operation of UA complying with requirements imposing technical mitigations like geofencing and electronic identification, posing a higher risk of severe injuries to people on the ground or damage to manned aircraft and operated by registered operators with higher competence.

Europe already has some experience of this issue and there are also International Organizations' recommendations that serve as a guidance in dividing uncontrolled airspace logically and clasifying drones. Problems of decision making under according to this recommendation we decided to create a system which will make drone exploitation easier, take the interests of any kind of clients into account, include pilot, the owner of the drone and the user of outsourced services. furthermore, the best interests of the public and private services will be

figured out so as not to overshadow their activities. Customers can register in UAS (unmanned aircraft systems) system, after that they can get competence to fly in the relevant airspace or register drone. Also one will be able to use outsource services. Worth to note that the user fills Flight Plan and if it is acknowledged by the system, it serves as a proof that the customer follows every kind of regulations. If the system rejects pre-filled flight plan this means that the flight plan is unsuitable for the system requirements and a message is received stating error in detail. In order to implement UAS completely it is fundamental to create affiliated systems such as zone control system, that means creating electronic maps including all information about restricted, prohibited, dangerous areas and so on.

The issues surrounding the creation of the UAS stems' mobile version and the scientific approach to solve these problems will be broadly presented in this report.

ARCHITECTURE OF THE DECISION-MAKING SYSTEM IN MEDICAL SYSTEMS RESEARCH

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The main component of object-oriented analysis in the development of an information system is the decomposition of the problem into separate classes of concepts (concept classes) or objects. Domain modeling is one of the initial stages of system design that is required to identify, classify, and formalize information about all aspects of the domain that determine the properties of the system being developed.

Subject area descriptions of medical systems research were made using the UML language and the Visual Paradigm CE tool. When modeling the subject area, the goal was that the designed software environment is intended for the input, storage and processing of information about medical systems research. The system should provide the following basic functions

- collection and processing of primary statistical medical information;
- development of compartmental mathematical control models (pharmacodynamics models) based on statistical data;
- development of compartmental models of pharmacokinetics;
- development of compartmental epidemiological models;
- decision making in the problems of medical diagnostics and prevention;
- quantitative prediction of the development of the spread of epidemic diseases;
- decision making in treatment tasks;
- making decisions on the form of the epidemic curve;
- development of immunoprophylactic measures;
- development of health insurance schemes.

STATIONARY LIMITS OF RENEWAL SHOT NOISE PROCESSES

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Let $(\xi_k)_{k \in \mathbb{N}}$ be a sequence of independent copies of a positive random variable ξ . Define a random walk $(S_n)_{n \in \mathbb{N}_0}$ via

$$S_0 := 0, \quad S_n = \xi_1 + \dots + \xi_n, \quad n \in \mathbb{N}.$$

For a measurable, locally bounded on $\mathbb{R}_+$ function $h: \mathbb{R}_+ \rightarrow \mathbb{R}$ define a *renewal shot noise process* $X = (X(t))_{t \in \mathbb{R}}$ by

$$X(t) := \sum_{k \geq 0}^{\infty} h(t - S_k) \mathbb{I}_{\{S_k \leq t\}}, \quad t \in \mathbb{R}.$$

Renewal shot noise processes are frequently used to model electric current in vacuum tubes, delays in settlements of insurance claims, seismic activity of a region and many other areas. In recent paper [1] the following result, which will be discussed in this talk, was obtained.

Theorem. Assume that $\mathbb{D}\xi < \infty$ and ξ has a spread-out distribution. Set $\mu = \mathbb{E}\xi$ and assume that h is a bounded, measurable function such that

$$\lim_{t \rightarrow \infty} h(t) = 0 \quad \text{and} \quad \int_0^{\infty} h^2(y) dy < \infty.$$

Then for any $m \in \mathbb{N}$ and $-\infty < u_1 < \dots < u_m < \infty$:

$$\left(X(t + u_i) - \frac{1}{\mu} \int_0^{t+u_i} h(y) dy \right)_{i=1, \dots, m} \xrightarrow{d} (X^*(u_i))_{i=1, \dots, m}, \quad t \rightarrow \infty,$$

where the stationary limit process X^* is defined as follows:

$$X^*(u) = \int_{[-u, \infty)} h(u + y) d\left(v^*(y) - \frac{y}{\mu}\right), \quad u \in \mathbb{R}.$$

Here v^* is the stationary renewal process. Stationary process X^* is the process with finite second moment and is continuous in mean square. Moreover, a convergence of second moments holds.

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INTERSECTION OF SETS WITH A FUZZY SET OF OPERANDS

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Assume that fuzzy sets F_j with the membership functions $\varphi_j(x)$, $j \in N$ are defined on a set X , where $N = \{1, 2, \dots, n\}$ is the set of their indices. Let $\tilde{N}$ be a fuzzy set on the set N with the arbitrary membership function $\eta(j)$, $j \in N$. A natural generalization of the classical intersection operation among fuzzy sets leads to the situation in which one considers the crisp set N as a fuzzy set $\tilde{N}$. In this way, the set $\tilde{F} = \bigcap_{(j, \eta(j)) \in \tilde{N}} F_j$ is defined by the membership function

$$y(x) = \min_{(j, \eta(j)) \in \tilde{N}} \varphi_j(x), \quad x \in X.$$

According to [1], for each fixed $\hat{x} \in X$, the values $y(\hat{x})$ form a fuzzy set $\tilde{\Phi}(\hat{x})$ on $J_{\hat{x}} \subseteq [0, 1]$. Therefore, the set $\tilde{F}$ is a type-2 fuzzy set (T2FS).

Definition [1]. The intersection $\tilde{F} = \bigcap_{(j, \eta(j)) \in \tilde{N}} F_j$ of fuzzy sets F_j , $j \in N$ with a fuzzy set $\tilde{N}$ of operands is the T2FS

$$\tilde{F} = \{((x, y), \varphi(x, y)) : x \in X, y \in J_x \subseteq [0, 1]\}$$

with the type-2 membership function $\varphi(x, y) = \max_{j \in N} \{\tilde{\eta}(x, j) \mid \varphi_j(x) = y\}$, $y \in J_x$, $x \in X$, where $J_x = \{y \in [0, 1] : \varphi_j(x) = y, j \in N\}$ is the set of primary membership degrees; for each fixed $x \in X$ the function

$$\tilde{\eta}(i, x) = \begin{cases} \eta(i), & i \in N^{PO}(x), \\ 0, & i \notin N^{PO}(x), \end{cases}$$

is the narrow of membership function $\eta(j)$, $j \in N$ to the set $N^{PO}(x) \subseteq N$ of Pareto optimal solutions to a two-criteria discrete optimization problem:

$$\varphi_i(x) \rightarrow \min, \eta(i) \rightarrow \max \quad \text{s.t.} \quad i \in N.$$

There are some applications of this notion in the different fields of operation research in the report.

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INFORMATIVENESS OF THE PARAMETERS OF DECISION MAKING MATHEMATICAL MODELS

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The problem of informativeness of the parameters for decision-making processes mathematical models is considered, a comparative analysis of approaches to this problem is given and an algorithm for solving it is described. Mathematical models of processes are characterized by a number of based parameters. New knowledge and efficiency of the solution, obtained as a result of applying of the constructed model to the study of real processes, depends on the informativeness of the basic parameters of mathematical models. The number of basic parameters of the model is a measure of the complexity of the models and the exclusion of non-informative parameters simplifies the model and its algorithmic implementation. Informativeness of parameters is the share of information that carry this parameter into the general scheme of the entire modeling process. The lack of a unified approach to the assessment of the informativity of the

model parameters creates difficulties in its study of considering processes. A model built without taking into account the informativeness of its parameters can be a model with "incomplete knowledge".

Problem of the informativeness of parameters of the models are at the intersection of several sections of modern applied sciences, such as systems analysis, computer sciences, measurement theory, the theory of identification, statistics and other fields. Different approaches and formulas are used for measure of information and has been studied its own characteristics. One of the most common, theoretically and practically justifying approaches to measuring of information is the Shannon formula. The theory of identification (the theory of inverse problems), which is also one of the fundamental branches of computer science and mathematical modeling, is associated with an assessment of the informativeness of the parameters of probabilistic models. The identifiability of model parameters is the ability to define them and is most closely related to their informativeness. Different conditions of identifiability are formulated on the basis of sufficient conditions of solvability of the model parameters identification problem. We prove the solvability of this problem when the parameters of the so-called "etalons" belong to the everywhere dense set of solutions. This is the most natural condition for identifiability of the model parameters [1,2].

We introduces the concept of gradations for any value in the range of its allowable values. Suppose that for some parameter of the model v , the i -th gradation is achieved with probability $p_i \in (0,1), i=1,2,...,n$. Then the information content of the parameter v of the model is defined as

$$I(v) = -\sum_{i=1}^n p_i \log p_i. \quad (1)$$

Let for the considering parameter given statistics with m tests. Suppose that from the m tests the i -th gradation of the parameter v is reached m_i times, $i=1,2,...,n$. Then the probability of reaching the i -th gradation of the parameter v will be calculated by the formula $p_i = m_i / m$, $i=1,2,...,n$. As a result, to calculate the informativeness of the parameter v of the mathematical model, from formulas (1) we have

$$I(v) = -\sum_{i=1}^n (m_i / m) \log(m_i / m). \quad (2)$$

As examples to the above, the rational formation of educational groups in schools and medical practice are considered. Numerical calculations are carried out in the MATLAB package.

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INFORMATIONAL SUPPORT FOR MANAGEMENT DECISION MAKING IN CUSTOMS AUTHORITIES

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Georgia is a member of the World Trade Organization for which is required to adhere the basic principles of the Convention adopted by it. These principles help to accelerate the country's foreign trade and create conditions favorable to legitimate trade. Compliance with these principles facilitates the control of goods and vehicles moving across the customs border of the country. At the same time, the risk of crossing the customs border of unreliable or completely undeclared goods increases. Practice has shown that this leads to decline in the level of economic security of the state, which may have a severe impact on the socio-economic status of the country.

The objective of this research is to develop a management decision-making information support system for customs authorities which will eliminate the above mentioned problem.

Our information research has shown that customs information space in Georgia does not fully meet the requirements of the customs management system, such as operational, technological decision making and management. It is necessary to reform the currently functioning automated information system, which will provide customs authorities with reliable operational information on the degree of their participation in foreign economic activity- export and import performance.

Based on our research- a number of problems have been identified as a result of the level of information support for management decision making in the customs authorities. One of the main problem is that there is no (exists in some cases but it is very weak) communication link

between the management of information and transmission of information between Georgia and foreign countries. All of this hampers the production of internal management reporting documents which is necessary to enable information exchange, does not allow effective and operational action to the highest level of management subordinates, which results in delayed feedback and inefficiency.

The concept of software and informational provision, presented in this study, is hierarchical structure of communicational intermediates, which is characterized by variety and remoteness in management and decision making, organizes united electronic documents' system, which meaningfully increases the speed of document exchange among unit partitions and, most importantly, the challenges of using resources of single global network and exchanging electronic documents between foreign countries will be solved successfully.

ANALYTICAL REPRESENTATION OF PERTURBATION FOR ONE CLASS OF PSEUDO-INVERSE OPERATORS

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The problems of studying pseudo-inverse operators, as well as related issues of their applications, are given constant attention in the scientific literature [1]. Moreover, the area of application of pseudo-inverse matrices is expanding and obtained theoretical results are used to solve practical problems [2, 3]. The subject of research in this publication is the application of the pseudo-inversion of matrix technique to solve linear regression analysis problems in conditions when matrices are elements of observations. Note that among recent publications there is a paper [4] devoted to the application of the pseudo-inversion technique in matrix Euclidean spaces.

Formulation of the problem. Let A_k , $k \in \overline{1, s}$ – the sequence of matrices with $(m \times n)$ dimension, elements of the matrix space $R^{m \times n}$.

The operator equation $\wp y \equiv \sum_{k=1}^s A_k y_k = Y$, is considered, where $y \in R^s$ – unknown vector, $Y \in R^{m \times n}$ – given matrix, $\wp y$ – linear operator,

operating from a finite Euclidean vector space R^s into another finite Euclidean space of matrices $R^{m \times n}$.

The problems of vector decomposition $y(\varepsilon) \in R^s$ are explored in the work, which is a solution of operator equation

$$(\wp + \varepsilon \wp_1)y(\varepsilon) \equiv \sum_{k=1}^s (A_k + \varepsilon A_k(1))y_k(\varepsilon) = Y, \quad (1)$$

$$A_k, A_k(1) \in R^{m \times n}, \quad k \in \overline{1, s},$$

with a small parameter ε ($0 < \varepsilon < 1$).

According to the assumption that the solution of equation (1) is known, within the theory of pseudo-inversion, SVD representations of the existing operator can be considered known $\wp$, as well as the pseudo inverse of it, projection operators. Therefore, for the problem in Euclidean space operator $\wp^* \wp: R^s \rightarrow R^{m \times n}$ and conjugate to it $\wp^*: R^{m \times n} \rightarrow R^s$ are considered, which operates in reverse to $\wp_\alpha$ direction [4]:

The solution of this problem is to determine the singularities $(\nu_j(\varepsilon), \lambda_j^2(\varepsilon))$, $j \in \overline{1, r}$, of perturbed operator $\wp^*(\varepsilon)\wp(\varepsilon)$ using the small parameter method [5]. Singularities of perturbed operator $\wp^*(\varepsilon)\wp(\varepsilon)$ are determined analytically with a known set of singularities of the unperturbed operator $\wp^*(0)\wp(0)$. The solution is obtained by the expression:

$$y(\varepsilon) = \wp^+ Y + \varepsilon \wp^+(1)Y + \\ + (E_2 - (\wp^+ Y + \varepsilon \wp^+(1)Y)(\wp y + \varepsilon \wp(1)y))w + o(\varepsilon), \quad w \in R^s.$$

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STATISTICAL SIMULATION OF THE INFORMATION SPREADING PROCESSES WITH STOCHASTIC PERTURBATIONS

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Consider the special case of basic model of spreading of any number of information messages in the society (for example [1]) with stationary parameters. We assume that the parameters of the intensity of communication are exposed disturbing influence. Then the model can be written as the system of Ito stochastic differential equations

$$dx_k(t) = \left[b_k x_k(t) \left(L - \sum_{i=1}^N x_i(t) \right) + \sum_{i=1}^N a_{ki} x_i(t) + c_k \right] dt + \\ + g_k x_k(t) \left(L - \sum_{i=1}^N x_i(t) \right) dw_k(t), t \in (0, T), x_k(0) = x_k^0, k = \overline{1, N}.$$

Here $w_k(t), k = \overline{1, N}, t \in (0, T)$ are Wiener processes, $dx_k(t)$ and $dw_k(t), k = \overline{1, N}, t \in (0, T)$ are stochastic differentials of processes $x_k(t)$ and $w_k(t), k = \overline{1, N}, t \in (0, T)$ (in the sense of Ito).

We use computer modeling for analysis of asymptotic stable of the model of information spreading processes in quadratic average in the area of special point case.

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GUARANTEED MEAN SQUARE LINEAR ESTIMATES OF PERIODIC MEAN VALUE OF STOCHASTIC PROCESSES

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Let $\xi(t) = (\xi_1(t), \dots, \xi_n(t))$ be a vector stochastic process such that $\xi(\cdot) \in M(0, T_1)$, where $M(0, T_1)$ is the space of stochastic processes with Lebesgue square integrable second moment on the interval $(0, T_1)$.

Assume that the mean value of the process $\xi(t)$ has the form $\mathbb{E}\xi(t) = H(t)\varphi(t)$, where $H(t)$ is a $k \times m$ matrix whose elements are continuous functions of the variable t on $[0, T_1]$, $\varphi(t)$ is a T -periodic vector-function that has the generalized derivative belonging to $L^2(0, T)$. We also suppose that function $\varphi(t)$ is unknown and its derivative belongs to a certain bounded set G in $L^2(0, T)$ and the process $\zeta(t) = \xi(t) - H(t)\varphi(t)$ belongs to some bounded set in the space $M(0, T_1)$.

We investigate the problem of finding guaranteed mean square linear estimates of vector-function $\varphi(t)$ from observation $\xi(t)$ on interval $(0, T_1)$.

It is established that if $T_1 = NT$ and

$$\lim_{N \rightarrow \infty} \min_{0 < t < T} \lambda_{\min}(Q_N) = \infty,$$

where $Q_N = \sum_{k=1}^N H_k^* H_k$, $H_k(t) = H(t + (k-1)T)$, $\lambda_{\min}(Q_N)$ is the least eigenvalue of matrix Q_N at fixed t , then the error of guaranteed estimation in the space $M(0, T)$ tends to zero.

For such errors we also deduce the estimates from above and below that, under certain conditions, are sharp.

Notice that this work is a continuation of our earlier studies set forth in [1], [2], where we elaborate the guaranteed estimation method for the case of linear periodic ordinary differential equations.

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MATHEMATICAL MODELS OF THE INFORMATION SPREADING PROCESS WITH JUMP DISCONTINUITIES AND SMALL PARAMETER

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Let us consider the case of basis model of information spreading process (for example [1] — [8]) with jump discontinuities (in particular [9]).

Let there be a certain social community of L people, potentially subject N information flows. Functions $x_k(t), k = \overline{1, N}, t \in (t_0, T)$ 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 $x_k(t), k = \overline{1, N}, t \in (t_0, T)$ the solutions of differential equations with the jump discontinuities in the time moments $t_j, t_j \in (t_0, T), j = \overline{1, M}$:

$$\left[\begin{array}{l} \dot{x}_k(t) = (a_k(t) + (b(t) + \varepsilon b_k(t))x_k(t)) \times \\ \quad \times \left(L - \sum_{i=1}^N x_i(t) \right), t \in (t_0, T), t \neq t_j, \\ \Delta x_k(t)|_{t=t_j} = x_k(t_j + 0) - x_k(t_j - 0) = \zeta_{j,k}, j = \overline{1, M}, k = \overline{1, N}. \\ x_k(t_0) = x_k^0, \end{array} \right. \quad (1)$$

Here ε is “small” parameter.

We apply the explicit solutions of the system (1). The results can be useful for algorithm development for estimation of dynamic of information spreading process with jump discontinuities and small parameters.

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HARDWARE-SOFTWARE FOR THE GRAVITATIONAL FIELD MEASUREMENT: MODELING, OPTIMIZATION AND DECISION MAKING

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All living organisms on Earth have evolved under a gravitational field. That's because gravity is always there and it is part of the background of our perceptual world. Nevertheless, gravity plays a fundamental role in human behavior and cognition. The central nervous system does not have "specialized" sensors for gravity. Rather, gravity is inferred through the integration of several sensory signals in a process termed graviception. This involves vision, our balance system and information from the joints and muscles. This report focuses on how to make the right decision in space in high pressure environments including gravitation field. Understanding how gravity impacts the way in which we make decisions has never been more pressing. This report also concentrates on the problem of designing and developing optical-cryogenic gravimeter using optimization techniques, modeling, and new materials. We show 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. Its function is based on the magnetic levitation phenomenon of the probe and on the measurement of its displacement with subsequent data processing. Long-duration exposure to zero gravity, such as during space missions, leads to several structural and functional changes in the human body. While the influence of zero gravity on our physical functions has been investigated, its effects on decision-making are not yet fully understood. Given the technical limitations and the expected gap of a few minutes in communication with Earth if we go to Mars, knowing the impact of altered gravity on how people make decisions is essential. Our results indicate that lying down does seem to influence how people make decisions, with participants struggling with random number generation. This indicates that people are therefore less prone to generating novel behaviors in the absence of gravity.

OPTIMAL PROCUREMENT DECISION-MAKING MAINTENANCE DATABASE

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The main topic of the report is the formation of the local information base for the implementation of the mathematical model of optimal procurement decision making, which will serve for the experts of the tender group. The local database is the simplest database. Within the local base, the base and program are deployed on the same computer. The database files are connected through the special drive or directly. The driver only handles the simple queries via **SQL** and provides the data transfer or storage in the spreadsheets. All other manipulations can only be performed through the program. Thus, the data and its attachments work in an integrated way and cannot be segregated. The most obvious and most common representatives of such databases are **Dbase** (files with .dbf extension), **Paradox** (.db extension) and **Access** (.mdb extension). **Dbase** and **Paradox** formats are not the databases but the spreadsheets, as only one data table can be saved in one file. Indexes that speed up searching and sorting process are in the separate files. Thus, the integrated database may consist of multiple files, which in many cases cause the different types of problems in the attachment process to the final user.

The local database, which will serve for the tender team's experts, includes all the information necessary to enable the interactive selection of potential bidders in the tender competition process.

The main problem with local databases is that the quality and speed of access depends directly on the driver. Therefore, in the presence of a large volume base, the demands are performed very slowly. In addition, „**Dbase**“ and „**Paradox**“ spreadsheets were developed a long time ago, and their weakest indicators are spreadsheets. The spreadsheets have no transactions and no corresponding log. After entering a new record, the driver fails to process it, and it means that there is the error in the changes to indexes. In „**Access**“ databases, there are no such kind of problems as their indexes are better protected.

The key attribute of the structured scheme of the interactive regime for maintaining the decision-making in the tender competition is the mathematical model database of optimizations. It consists of a

mathematical model that includes the computational formulas for comparing alternatives:

- The main criteria for identifying contractors;
- The alternative offers of the potential executors;
- The final ranking vector;
- The different criteria;
- The legislative acts;
- etc.

Through this data, each member of the expert team makes the calculations in an interactive manner, based on the results, they make the decision to select a potential executor in the competition.

FIRST-ORDER LOGICS OF PARTIAL PREDICATES WITH COMPOSITION OF PREDICATE COMPLEMENT

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The apparatus of mathematical logic forms the basis for information and software systems. Therefore, the problem of constructing new program-oriented logical formalisms is very important. In this paper we study new software-oriented logics of partial predicates with special non-monotonic operation (composition) of the predicate complement $\sim$; we denote these logics by LC. Such operations are used in various versions of the Floyd-Hoare program logic with partial pre- and post-conditions.

We describe first order composition algebras and LC languages. For LC, a number of logical consequence relations ($P_c|_T, P_c|_F, R_c|_T, R_c|_F, P_c|_{TF}, R_c|_{TF}, P_c|_{IR}$) and logical consequence relations under the conditions of undefinedness ($P|_T^\perp, P|_F^\perp, R|_T^\perp, R|_F^\perp, P|_{TF}^\perp, R|_{TF}^\perp$) are specified. We consider properties of the defined relations. For the introduced relations, we describe the conditions for their guaranteed presence, the decomposition conditions for formulas and the properties of quantifier elimination.

The theorem of elimination of the conditions of undefinedness for the relations $|_T^\perp$ and $|_F^\perp$ is proved. Thus, the relations $P|_T^\perp, P|_F^\perp, R|_T^\perp$ and $R|_F^\perp$ can be expressed by $P_c|_T, P_c|_F, R_c|_T$ and $R_c|_F$ respectively. However, it is shown that $|_{IR}^\perp$ cannot be expressed by $P_c|_{IR}$. Moreover,

it is impossible to define correctly the decomposition conditions for $\sim\Phi$ formulas for $^{Pc}|_{IR}$. It is also worth pointing out that properties of decomposition conditions for $\sim\Phi$ formulas are different for the relations $|=_{\mathcal{T}}$ and $|=_{\mathcal{F}}$.

For the introduced logical consequence relations for LC and logical consequence relations under the conditions of undefinedness we construct first order sequent calculi and prove the correctness and completeness theorems.

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ON THE RESEARCH OF HEALTH CONDITION AND SOCIAL-ECONOMIC CHARACTERISTICS DEPENDENCY

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In this article, we present an analysis of dependency of health conditions on social-economic characteristics of one Ukrainian region. The health condition indicators were obtained during screening test of over 20 thousand persons. 400 different measures of quantitative indicators of the electrocardiogram were collected for each person. The region of interest is divided into several districts. Each district is characterized by a set of social-economic characteristics (e.g. population size, average monthly salary, number of registered unemployed persons, the average number of full-time employees, provision of population with housing, old and emergency housing, number of active tuberculosis incidences, etc.). The ultimate goal is to discover the dependency structure between the health condition and characteristics of the district.

For each health condition indicator, we have determined a “normal” (or healthy) value. Then for each observation (person) inside each district, we have computed a Mahalanobis distance. In order to determine the dependency between health conditions and social-economic characteristics, we need to build a regression model. In the

first step of the analysis, we perform a correlation analysis of social-economic characteristics in order to determine and exclude linearly dependent variables. After the first step, a set of social-economic characteristics was reduced from 254 characteristics to 140. Then we perform Principal component analysis (PCA) on a reduced set of characteristics. The final step of the research is to build a regression model with a Mahalanobis distance of health condition as a dependent variable and a set of principal components as independent variables.

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ON CONTROLLED QUEUE WITH THE LIMITED NUMBER OF RETRIALS AND CONSTANT RETRIAL RATE

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In this paper, we consider a two-dimensional Markov process $Q(t) = (Q_0(t), Q_1(t))^T$, $t \geq 0$ with continuous time in phase space $S = \{0, 1, \dots, c\} \times \mathbb{Z}_+$, where $Q_0(t)$ is the number of busy servers at time t , $Q_1(t)$ is the number of sources of repeated attempt (the number of customers in orbit) at time t . $Q(t)$, $t \geq 0$ describes the service process in a multi-channel queueing system with a single retrial attempt to begin service process and a retrial rate does not depend on the number of sources of repeated attempt. Such system is determined by next parameters: λ_j is the rate of input flow that depends on the number of sources of repeated attempt, μ is the service rate and ν is the rate of repeated attempt.

For this system we consider situation when the rate of input flow is controlled by 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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SIMULATION ACCURACY OF INPUT SIGNAL ON THE LINEAR SYSTEM IN $L_2([0,T])$

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We consider a Gaussian stochastic processes with discrete spectrum. These processes are supposed to be as input processes to a time-invariant linear system with real-valued square integrable impulse response function. The response on the system is an output process. The model which approximates the process with given accuracy and reliability in Banach space $L_2([0,T])$ is constructed taking into account the response of the system. For these purposes the methods and properties of Square-Gaussian processes are used.

A stochastic process with discrete spectrum can be written in this way

$$X(t) = \sum_{k=0}^{\infty} b_k (\xi_k \cos \lambda_k t + \eta_k \sin \lambda_k t),$$

where ξ_k, η_k are independent zero-mean random variables,

$$E\xi_k = E\eta_k = E\xi_k \eta_l = 0 \text{ and } E\xi_k \xi_l = E\eta_k \eta_l = \delta_k^l, k \geq 0, l \geq 0.$$

If random variables ξ_k, η_k are Gaussian then the random process $X(t)$ will be also Gaussian. We consider a Gaussian stochastic process with discrete spectrum.

Consider a time-invariant linear system with a real-valued square integrable impulse response function $H(\tau)$ which is defined on a finite domain $\tau \in [0, T]$. This means that the response of the system to an input signal $X(t)$ which is observed on $[-T, T]$ has the following form

$$Y(t) = \int_0^T H(\tau) X(t-\tau) d\tau, \quad t \in [0, T]$$

and $H \in L_2([0, T])$.

Suppose that the impulse response function is known. The response of the system $Y(t)$ can be presented as $Y(t) = \sum_{k=0}^{\infty} (\xi_k \cdot c_k(t) + \eta_k \cdot s_k(t))$,

where the functions $c_k(t)$, $s_k(t)$ are equal to

$$c_k(t) = b_k \int_0^T H(\tau) \cos(\lambda_k(t-\tau)) d\tau, \quad s_k(t) = b_k \int_0^T H(\tau) \sin(\lambda_k(t-\tau)) d\tau, \quad t \in [0, T].$$

Definition 1. A random process $X_N(t)$ is called a model of the process $X(t)$ if

$$X_N(t) = \sum_{k=0}^N b_k (\xi_k \cos \lambda_k t + \eta_k \sin \lambda_k t).$$

If the model $X_N(t)$ is considered as an input signal of linear system then the output process is given in this way

$$Y_N(t) = \sum_{k=0}^N (\xi_k \cdot c_k(t) + \eta_k \cdot s_k(t)).$$

Under $\xi_N(t)$ we denote the sum of square of the differences $X(t) - X_N(t)$ and $Y(t) - Y_N(t)$ $\xi_N(t) = (X(t) - X_N(t))^2 + (Y(t) - Y_N(t))^2$.

Definition 2. We say that the model $X_N(t)$ approximates a stochastic process $X(t)$ taking into account the response of the system with given reliability $1-\nu$, $\nu \in (0, 1)$, and accuracy $\delta > 0$ in the space $L_2([0, T])$, if

$$P \left\{ \int_0^T |\xi_N(t) - E \xi_N(t)|^2 dt > \delta \right\} < \nu.$$

Consider such conditions:

- A) There exists a constant $c > 0$ that dominates the impulse response function $H(\tau)$ on the domain $[0, T]$ $|H(\tau)| \leq c$.
- B) The following integral is convergent $I_H = \int_0^T H^2(\tau) d\tau < \infty$.
- C) The series $\sum_{k=N+1}^{\infty} b_k^2 \lambda_k^i < \infty$, $i = 0, -1$.

Theorem. Assume that the conditions A, B and C are met. The model $X_N(t)$ approximates a Gaussian stochastic process with discrete spectrum $X(t)$ taking into account the response of the system (1) with

given reliability $1-v$, $v \in (0,1)$, and accuracy $\delta > 0$ in the space $L_2([0,T])$ if for N the inequalities

$$\delta > \left(\frac{2}{\sqrt{2}} + 4 \right) \delta_0(N),$$

$$2 \exp \left\{ - \frac{\delta^{1/2}}{\sqrt{2\delta_0(N)}} \right\} \left(1 + \frac{\sqrt{2\delta}}{\sqrt{2\delta_0(N)}} \right)^{1/2} < v,$$

hold true, where

$$(\delta_0(N)) = (8 + 2T^2 \cdot I_H^2) \left(\sum_{k=N+1}^{\infty} b_k^2 \right)^2 + (64c^2 + 2 \cdot I_H^2) \left(\sum_{k=N+1}^{\infty} b_k^2 \lambda_k^{-1} \right)^2$$

$$+ 4T \cdot I_H^2 \left(\sum_{k=N+1}^{\infty} b_k^2 \right) \left(\sum_{k=N+1}^{\infty} b_k^2 \lambda_k^{-1} \right)$$

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ASYMPTOTIC DISSIPATIVITY FOR MERGED STOCHASTIC EVOLUTION SYSTEMS WITH MARKOV SWITCHES AND IMPULSE PERTURBATIONS UNDER POISSON APPROXIMATION CONDITIONS

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Dissipativity as a property of deterministic systems and systems with random perturbations was widely considered in the literature, in particular, in [1] and [3]. The dissipation is closely connected with Lyapunov's stability. This makes it possible to apply the dissipative method to the study of the same methods as for the study of stability, in particular, with the help of Lyapunov functions.

The stochastic evolution system in the ergodic Markovian environment is given by a stochastic differential equation [7]

$$du^\varepsilon(t) = C(u^\varepsilon(t), x(t/\varepsilon^2))dt + \varepsilon d\eta^\varepsilon(t), \quad u^\varepsilon(t) \in \mathbb{R}, \quad (1)$$

where the Markov process $x(t/\varepsilon^2)$, $t \geq 0$ is determined on a standard phase space $(E, \mathcal{E})$ with splitting

$$E = \bigcup_{k=1}^N E_k, \quad E_k \cap E_{k'} = \emptyset, \quad k \neq k'$$

in a series of series with a small parameter series, $\varepsilon \rightarrow 0$.

The obtained results make it possible to determine the asymptotic characteristics of the aggregated evolution systems, which are considerably simpler to analyze than the initial systems in the form of stochastic differential equations with impulse perturbation under conditions of Poisson approximation and Markov switches.

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A NOVEL PROXIMAL METHOD FOR VARIATIONAL INEQUALITIES OVER THE SET OF SOLUTIONS THE EQUILIBRIUM PROBLEMS

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Let H be a real Hilbert space with inner product $(\cdot, \cdot)$. For operator $T: H \rightarrow H$, set $M \subseteq H$, and bifunction $F: H \times H \rightarrow \mathbb{R} \cup \{+\infty\}$ we denote by $VI(T, M)$ and $EP(F, M)$ sets

$\{x \in M : (Tx, y - x) \geq 0 \quad \forall y \in M\}$ and $\{x \in M : F(x, y) \geq 0 \quad \forall y \in M\}$, respectively.

We are interested in approximate solution of problem

$$\text{find } x \in VI(T, EP(F_1, M_1) \cap EP(F_2, M_2)). \quad (1)$$

Motivated by the idea of Halpern method for common fixed point problem, Korpelevich's extragradient method and Antipin's extensions the extragradient method to equilibrium problem, we'll introduce a new and efficient method for solving problem (1). One variant of this method is following.

Select $x_1 \in H$ and generates the sequence (x_n) iteratively by

$$\begin{aligned} v_n &= \text{prox}_{\lambda_n F_1(x_n, \cdot)} x_n, & y_n &= \text{prox}_{\lambda_n F_1(v_n, \cdot)} x_n, \\ w_n &= \text{prox}_{\lambda_n F_2(x_n, \cdot)} x_n, & u_n &= \text{prox}_{\lambda_n F_2(w_n, \cdot)} x_n, \\ z_n &= \frac{1}{2} y_n + \frac{1}{2} u_n, \\ x_{n+1} &= z_n - \alpha_n T z_n, \end{aligned}$$

where $\lambda_n > 0$, $\alpha_n > 0$.

This method uses the proximity operator. Principal difference here, at each iteration, we solve strongly convex programming problems only instead of a auxiliary equilibrium programming problems.

PROBLEMS OF LEXICOGRAPHICAL OPTIMIZATION WITH SEPARABLE FUNCTIONS OF CRITERIA

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For problems of the vector optimization an exact solution is not always achievable. So, it is rational to replace formally an input problem with a simpler one not to change optimal solutions. There are different approaches to simplify the mathematical model of the problems [1 2]. In particular, by substituting of variables and in some problems nonlinear private functions of criteria are reduced to separable functions.

We regard the optimization problem $L(F, X) : \min^L \{F(x) | x \in X\}$,

where $F(x) = (f_1(x), \dots, f_l(x))$, $f_k(x) = \sum_{j=1}^n f_{kj}(x)$, $k = 1, 2, \dots, l$,

$X = \{x \in R^n \mid g^i(x) \leq 0, x \geq 0, i = 1, 2, \dots, m\}$, $g^i(x)$ – are continuously differentiated convex functions. Accurately approximating private criteria $f_k(x)$, $k = 1, 2, \dots, l$, by piecewise linear analogues $\tilde{f}_k(x)$, we obtain for the problem $L(F, X)$ approximate analog $L(\tilde{F}, X)$: $\min^L \{\tilde{F}(x) \mid x \in X\}$, where $\tilde{F}(x) = (\tilde{f}_1(x), \dots, \tilde{f}_l(x))$, $X = \{x \in R^n \mid g^i(x) \leq 0, x \geq 0, i = 1, 2, \dots, m\}$.

The local optimum $L(\tilde{F}, X)$ is correspondingly the approximate optimum of the problem $L(F, X)$. To find the lexicographical local optimum of the approximate problem $L(\tilde{F}, X)$, the algorithm suggested in [3] is used.

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ONTOLOGY FOR SYSTEM OPTIMIZATION PROBLEMS IN THE ELECTRIC VEHICLES DOMAIN

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Over the last 20 years, the concentration of nitrogen dioxide and formaldehyde within Kyiv has increased by 50 and 200%, respectively. These gases are very dangerous, because the first can reduce lung function, and the second – causes degenerative processes in the parenchymal organs and sensitizes the skin. The reason for this is the

increase of vehicles in the city. As a result, an increase in the emissions into the atmosphere. The way out of the situation is the use of electric vehicles (EV). According to June 2019, the most popular EV in 2018 in Ukraine were (in units): Nissan Leaf – 3378, BMW i3 – 352, Tesla Model S – 259, Mercedes-Benz B-Class Electric Drive, Smart For two Electric Drive, Tesla Model X, KIA Soul EV, Volkswagen e-Golf, Toyota RAV4 EV, Fiat 500e – 37. Also Renault Zoe, Renault Kangoo ZE, Kia Soul EV, Hyundai Ioniq E, which entered the Ukrainian market in 2018. To date, there are nearly twenty thousand electrically-powered cars in Ukraine, including 10,714 fully EV and 2,054 charging stations, with a total of 4,069 charging points. Approximately 6 electric cars per 1 charging station, although it is considered that for the normal functioning of the infrastructure of EV, one station shouldn't over exceed 3 EV. The paper offers mathematical methods and software to solve some of the problems of the domain that supports the infrastructure of the electro mobility business. Knowledge [4-6] from the subject area EV is analyzed and systematized. An ontology [1,2] is being formed, which makes it possible to consider all factors of strength and weakness, opportunities and threats from this popular mode of transport. Further, on the basis of ontological research, models of system optimization for selected problems are built [3, 4]. This allows you to immediately use the data obtained to solve the series of problems related to electric transport. The software allows you to confirm the efficiency of EV when choosing between a gasoline and an electric car.

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ALGORITHMS FOR SOLVING PROBLEMS USING MATHEMATICS OF FUNCTIONAL INTERVALS

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There are proposed two classes of algorithms for solving problems R^n using mathematics of functional intervals.

The methods of the first one use the decomposition method and simplified mathematics of functional intervals in R^1 . Implementing them, we distinguish a set $\{\varphi_{i1}(x_i), \varphi_{i2}(x_i), \dots, \varphi_{ik_i}(x_i)\}$ of functions $\varphi_{ij}(x_i)$ of only one argument $x_i, (i = \overline{1, n})$ from the analytic expression of the given function $f(x_1, x_2, \dots, x_n)$ and apply simplified mathematics of functional intervals in R^1 to construct a functional interval $\Phi_{ij}(X_i) = \{X_i, \underline{c}_{ij}(x_i), \bar{c}_{ij}(x_i)\}$ of each function $\varphi_{ij}(x_i), (j = \overline{1, k_i})$, each such set of functions. Here, $X_i = \bigcup_{k=1}^{m_{ij}-1} X_{ijk} = \bigcup_{k=1}^{m_{ij}-1} [\underline{x}_{ijk}, \bar{x}_{ijk}]$, m_{ij} - the number of characteristic points of a function $\varphi_{ij}(x_i)$ in the interval, X_i , $\underline{x}_{ijk}, \bar{x}_{ijk}$ - its adjacent characteristic points.

The methods of the second of these classes use the decomposition method, the simplified mathematics of functional intervals, and the complete mathematics of functional intervals. In this case, as in the previous class of methods, we construct the functional intervals $\Phi_{ij}(X_i)$ of each function $\varphi_{ij}(x_i), (j = \overline{1, k_i})$ and the linear functional intervals $L\Phi_{ij}(X_i)$ of the same functions by the complete mathematics of functional intervals in R^1 . So we get sequences of the same but one-dimensional problems at each coordinate, each of which is solved by means of mathematics of functional intervals in R^1 .

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BILEVEL OPTIMIZATION PROBLEMS OF DISTRIBUTION OF INTERBUDGET TRANSFERS

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The problems of optimal distributing of transfers are defined and investigated within given budget limitations with the purpose of maximization of social welfare in accordance with predefined criteria [1, 2]. They join in the wide class of the applied problems, related to distribution of the limited resources in the hierarchical systems. In accordance with [3], mathematical model is presented as a bilevel optimization problem, containing the linear optimization problem of top

level $P(L): \max \left\{ \sum_{i=1}^m \langle c^i, \bar{y}^i(x^i) \rangle \mid x = (x^1, \dots, x^m) \in X \right\}$, and linear problems

of integer optimization at the bottom level $P^i(F):$

$\max \left\{ \langle d^i, y^i(x^i) \rangle \mid y^i(x^i) \in G_i(x^i) \right\}, i \in N_m$, whose optimal solutions $\bar{y}^i(x^i)$

are used for setting a feasible region of a bilevel problem. Both optimistic and pessimistic versions of the problem on optimal distribution of transfers were considered. For the approximate solution of the optimistic version of a bilevel problem on the basis of method of directing neighbourhoods [4, 5] the algorithm of finding of solutions for parametric problems of integer programming of a lower level was proposed. Integer programming problem with Boolean variables of a higher level is solved based on local algorithms.

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**INVESTIGATION OF THE CONVERGENCE
OF THE NEWTON-KURCHATOV METHOD
UNDER WEAK CONDITIONS**

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Consider the problem of finding the approximate solution of an equation

$$H(x) \equiv F(x) + G(x) = 0, \quad (1)$$

where F and G are nonlinear operators defined on an open convex set D of a Banach space X with values in a Banach space Y . F is a Fréchet-differentiable operator, G is a continuous operator.

For the numerical solving of the problem (1), we proposed a Newton-Kurchatov method

$$x_{n+1} = x_n - [F'(x_n) + G(2x_n - x_{n-1}; x_{n-1})]^{-1} H(x_n), \quad n \geq 0. \quad (2)$$

In [2], we studied the semilocal convergence of the method (2) under the Ω -conditions and ε -conditions for derivatives and first-order divided differences. Note that the Ω -conditions generalize the classical Lipschitz and Hölder conditions and do not require the differentiability of a nonlinear operator.

A new technique for studying the convergence of iterative methods for solving nonlinear problems was proposed in [1]. It involves the use of center conditions at the point of the solution or initial approximation and restricted conditions at arbitrary points for derivatives (divided differences). This makes it possible to extend the applicability of the iterative method. The theoretical results are confirmed by numerical experiments. This approach is used to study the semilocal convergence of the method (2). As a result, we have received weaker criteria for the semilocal convergence and tighter error estimations.

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OPTIMAL ESTIMATES IN THE PROBLEMS OF EXTRAPOLATIONS, FILTRATIONS, AND INTERPOLATIONS OF CERTAIN FUNCTIONALS

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The work [1] deals with a system of some evolutionary differential equations, non-linear and corresponding to it linear

Let $R^2(t,s)=e^{-\lambda|t-s|}$ (this way we can choose $R^2(t,s)$), with a known spectrum of eigenvalues $\{\lambda_k\}$ and eigen functions $\{\xi_u(t)\}$, as is known from the theory of integral equations.

In the proposed work, this fact is used for the results obtained in [1], the optimal estimates in the tasks set are calculated finally, up to a number.

Thus, the formulas for optimal estimates $h(y(t))$ of a certain functional $h'(y(t))$, when observing some other functional $g(y(t))$, where the functions $h(\cdot)$ and $g(\cdot)$ are defined on a Hilbert space H under the conditions that the spectrum of the operator function $R^2(t,s)$, $\{\lambda_k\}$ and $\{\xi_k(t)\}$ is calculated in an explicit form, which will allow to draw up a program for their final calculation to a number.

As shown in work [1], the optimal estimate $h(y(t))$ can be expanded in powers of the small parameter α ; the expansion coefficients also contain the spectrum of the operator $R^2(t,s)$. Therefore, they can be calculated up to a number under the conditions of the spectrum of the operator $R^2(t,s)$.

Thus, in the particular case when the well-known spectrum of the correlation function operator $R^2(t,s)=e^{-\lambda|t-s|}$ of optimal estimates $h(y(t))$, in problems of extrapolations, filtrations and interpolations of some functionals $h(y(t))$, while observing some other functionals $g(y(t))$ obtained in [1], it is possible to get their final value in numbers with their software.

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DYNAMICS INVESTIGATION OF ONE COMBAT MODEL WITH TIME-DELAY

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The one Lanchester model of combat operations is considered [1]. Let each of the parties (parties of blocks) build up its arms in proportion to the volume of the enemy's weapons. If $x(t)$ and $y(t)$ are weapons level of the two sides, then the dynamics of the build-up of weapons can be written down by a system of two equations

$$\dot{x}(t) = ky(t), \quad \dot{y}(t) = lx(t).$$

The coefficients $k > 0$, $l > 0$ are interpreted as parameters of the reaction of each of the parties to the armament of another. The equilibrium point of such a system is a saddle. And, if the initial data lie on the separatrices, then the solutions increase exponentially. The arms grow to infinity. Economic factors affect the reduction of the growth rate of weapons by an amount that is proportional to the existing weaponry. In this case, the model will be written as

$$\dot{x}(t) = ky(t) - ax(t), \quad \dot{y}(t) = lx(t) - by(t).$$

The coefficients $a > 0$, $b > 0$ are called coefficients of "tiredness". The equilibrium point is node (degenerate node) or saddle. The condition of asymptotic stability is the positivity of the coefficients, namely $ab > lk$ (stable node). If the parties constantly increase their arms, then the system becomes a linear non-uniform system

$$\dot{x}(t) = ky(t) - ax(t) + g, \quad \dot{y}(t) = lx(t) - by(t) + h.$$

Here the constants $g > 0$, $h > 0$ are responsible for the possibility of armament. Given the time taken to make decisions in the development of weapons and technical delays in its implementation, the more adequate model will be a system of differential equations with a time-delay

$$\dot{x}(t) = ky(t - \tau) - ax(t) + g, \quad \dot{y}(t) = lx(t - \tau) - by(t) + h.$$

In the report we obtained a solutions presentation in analytic form, using a special function that is called delay-exponential.

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VALUATION OF DERIVATIVES AND RISK MANAGING

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Post the financial crisis of 2008 it has been clear that risk considerations must enter into the valuation of derivatives, previously performed in an entirely "risk neutral world".

The aim is to propose such valuation of derivatives, in which enter an additional risk parameters, connecting with VaR or CVaR and which defines an "optimal" (with regard to criterion of maximization of profit function) value of option for investor.

In this paper will be demonstrated that the link between optimal option value, risk measuring and risk managing is especially close, and it is given by stochastic optimization. The average value-at-risk is related to the problem of investor [1], which we use for option pricing. Let $Y = (S - K)^+$ is payoff for call option, where strike price K and premium C is known to investor and distribution of underlying risky assets S is modeled. Suppose that an investor has to decide about the amount X of invest before the actual available income is given to him by random variable The total piecewise linear profit/cost function is

$$H = X - u(Y - X)^- + l(Y - X)^+ = (1-l) \left(X - \frac{(u-l)}{(1-l)} (Y - X)^- \right) + lY.$$

The optimal decision X should maximize the expected profit $E(H(X,Y))$. Finally the optimal decision (optimal option price) is

$x = G^{-1}(\alpha)$, where $\alpha = \frac{1-l}{u-l}$, G is the distribution function of Y .

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OPTIMAL CONTROL FOR DIFFERERECE EQUATIONS WITH RANDOM COEFFICIENTS

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The system of linear difference equations with random coefficients is considered

$$X_{n+1} = A(\xi_{n+1}, \xi) X_n + B(\xi_{n+1}, \xi) U_n \quad (n=0,1,2,\dots), \quad (1)$$

where ξ_n — Markov process, which is determined by the system of difference equations

$$p_k(n+1) = \sum_{s=1}^q \pi_{ks} p_s(n), \quad p_k(n) \equiv P\{\xi_n = \theta_k\} \quad (k=1,\dots,q, n=0,1,2,\dots). \quad (2)$$

Control vector U_n is found from the minimum condition of the quadratic functional

$$v = \left\langle \sum_{n=0}^{\infty} X_n^* Q(\xi_n) X_n + U_n^* L(\xi_n) U_n \right\rangle. \quad (3)$$

The optimal control has a form

$$U_n = S(\xi_n) X_n \quad (n=0,1,2,\dots). \quad (4)$$

Synthesis of optimal control, that is, the search for matrices $S_k = S(\theta_k)$ ($k=1,\dots,q$) in the formula (4) comes down to finding the minimum of functional

$$v = \sum_{k=1}^q C_k \circ D_k(0) \quad (5)$$

under fulfillment of conditions

$$C_k = Q_k + S_k^* L_k S_k + \sum_{s=1}^q \pi_{sk} (A_{sk} + B_{sk} S_k)^* C_s (A_{sk} + B_{sk} S_k) \quad (k=1,\dots,q). \quad (6)$$

We have the conditional extremum problem. Let us form the Lagrange function with Lagrange matrix multipliers Λ_k ($k=1,\dots,q$).

The system of equations determines the necessary conditions for optimality of solutions of the difference equations system (1) and can be found by the method of successive approximations.

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MOMENT STABILITY OF RANDOM SOLUTIONS OF A SYSTEM OF LINEAR DIFFERENTIAL EQUATIONS WITH RANDOM LINEAR JUMPS OF SOLUTIONS

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The moment stability of random solutions of the linear differential equations system with constant coefficients is investigated. Solution of the system has linear jumps occurring at random moments, which are defined by the jumps of a finite-valued Markov process. The values of the jumps are determined by states of Markov process before and after the jump.

The finite-valued Markov process $\xi(t)$, which can be in q different states $\theta_1, \theta_2, \dots, \theta_q$ with probabilities

$$p_k(t) = P\{\xi(t) = \theta_k\} \quad (k=1,2,\dots,q), \quad (1)$$

is considered. Probabilities satisfy the system of differential equations

$$\frac{dp_k(t)}{dt} = \sum_{s=1}^q \alpha_{ks} p_s(t). \quad (2)$$

Here the constant coefficients α_{ks} ($k,s=1,2,\dots,q$) fulfill the known ratios [1]

$$\alpha_{ks} < 0, \quad \sum_{s=1}^q \alpha_{ks} = 0, \quad \alpha_{ks} \geq 0 \quad (k \neq s), \quad (k,s=1,2,\dots,q).$$

The Markov process $\xi(t)$ changes its value at random times t_j ($j=0,1,2,\dots$) by jumps.

Simultaneously with the Markov process $\xi(t)$ the following system of the linear differential equations is considered

$$\frac{dX(t)}{dt} = AX(t), \quad t \neq t_j, \quad (j = 0, 1, 2, \dots), \quad (3)$$

which changes its values by jumps at moments t_j according to the rule below

$$X(t_j + 0) = C_{ks} X(t_j - 0), \quad (4)$$

if the random process moves from state θ_s to state θ_k ($k \neq s$).

Here C_{ks} – constant matrices. The solution of system (3) will be random. In this paper, the stability of solutions on the average and mean-square stability are investigated. Moreover, the derived equations determine the necessary and sufficient conditions for asymptotic stability.

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THE ADAPTIVE SEARCH ALGORITHMS ON THE EXAMPLE OF SEARCH ARTICLES SYSTEM

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The adaptive search algorithms are a considerable part of the modern recommendation systems-software techniques providing suggestions for useful items to a user. The main task of adaptive search algorithms is to analyze the pre-collected information about the user and to calculate the search result. The search result is a personalized recommendation that offered as ranked lists of items.

This work considers algorithms from the group based on the data about the user activity, their possible enhancing, and based on information about the behavior history from all users of the system.

The one of popular algorithm is "neighbor's algorithm", when we need to find the measure of proximity, filter users with a degree of proximity above a certain value, find items that the user "a" may like, based on the ratings of a filtered user group. Another algorithm used for

work with matrices in the recommendation systems, in order to select those objects that the user might like is SVD (Singular Values Decomposition) algorithm. But both algorithms partially do not give the desired accuracy of the result. In this case the hybrid model is used - to improve the results, to minimize the disadvantages of the methods, maximizing their benefits. First, we should use different samples for the neighbor's algorithm, combine results and selecting the best values. Thus, we get the maximum value from all samples, reducing the possibility of skipping objects that may be absent in more narrow samples.

The result transmitted for "shifting" with the result obtained in the SVD, using the analogous algorithm for the comparison of objects in the samples: get sample of SVD, compare Y with sample, shuffle samples, create new sample Z. From Z, you can output the result - recommendations.

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LEAST SQUARES ESTIMATES WITH LEAST DEVIATIONS FROM 'ATTRACTION' POINTS OF TIME-VARYING PARAMETER FOR BILINEAR DYNAMIC SYSTEMS UNDER UNCERTAINTIES

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The parameter estimation problem of slowly time-varying block matrix $\mathfrak{A} = (A B_1 B_2 \dots B_m B)$ is considered for bilinear object:

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

in the case when for this unknown matrix additionally its ‘attraction’ point $\mathfrak{A}_*(N) = (A_*(N) B_{1*}(N) B_{2*}(N) \dots B_{m*}(N) B_*(N))$ is known at any moment where $x(k), u(k) = (u_1(k), u_2(k), \dots, u_m(k))^T, \xi(k)$ are state, control and disturbance vectors respectively.

The least squares estimate with variable forgetting factor $\lambda(k)$ ($\lambda(k) \in (0, 1], k \in \mathbb{N}$) is investigated for system (1) under non-classical assumptions when this estimate may be not unique.

The set of all above mentioned estimates is defined as

$$\text{Arg min}_{\mathfrak{A}} Q(\mathfrak{A}, N), \quad (2)$$

where

$$Q(\mathfrak{A}, N) = \sum_{k=1}^N w(k, N) \|\xi(k)\|^2, \quad w(k, N) = \begin{cases} \prod_{i=k}^{N-1} \lambda(i), & \text{if } k = \overline{1, N-1}, \\ 1, & \text{if } k = N. \end{cases}$$

The required unique estimate $\hat{\mathfrak{A}}(N)$ on estimate set (2) is proposed as least squares estimate with variable forgetting factor $\lambda(\bullet)$ and least deviation norm from given ‘attraction’ point $\mathfrak{A}_*(N)$ at any moment N in this case.

Explicit and recurrent forms of representation are obtained for parameter estimate $\hat{\mathfrak{A}}(N)$ of non-stationary block matrix $\mathfrak{A}$ for bilinear system (1) under these non-classical suppositions. The recurrent algorithm for corresponding weighted residual sum of squares is also proposed.

MONOTONE DIFFERENCE SCHEME FOR SINGULARLY PERTURBED SECOND DEGREE EQUATION

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Singularly perturbed equations are characterized by the presence of a small parameter at a higher derivative. Numerous methods for solving such problems are of great importance for the study of complex

problems in physics, chemistry, economics. These problems include, in particular, boundary value problems the convection-diffusion-reaction equation with predominant convection.

In this paper, a numerical method based on a parabolic spline is proposed to solve the boundary-value problem for the convection-diffusion-reaction equation with prevailing convection. This algorithm increases the efficiency of solving convection-diffusion-reaction equations with convection predominance by controlling the parameters of the difference scheme, which allows to reduce the numerical procedure to the solution of a system of linear equations with a non-degenerate matrix.

Consider the boundary value problem for the stationary convection-diffusion-reaction equation

$$D(x)\frac{d^2u(x)}{dx^2} - V(x)\frac{du(x)}{dx} - Au(x) = -f(x), \quad x \in (0, L), \quad (1)$$

$$V(x) \neq 0, \quad D(x) > 0, \quad A > 0, \quad (2)$$

$$u(0) = U_0, \quad u(L) = U_L. \quad (3)$$

Let grids Δ_x and Δ_τ be given at the segment $[0, L]$

$$a) \Delta_x: 0 = x_0 < x_1 < \dots < x_N = L,$$

$$b) \Delta_\tau: 0 = \tau_0 < \tau_1 < \dots < \tau_{N-1} = L, \quad (4)$$

where $x_i < \tau_i < x_{i+1}$, $i = \overline{1, N-2}$. Let us denote $h = \tau_i - \tau_{i-1}$, $\mu_i = \tau_i - x_i$.

Let's look for a solution to the problem in the form of a parabolic spline. Let $V(x) = V = \text{const}$, $D(x) = D = \text{const}$ and $\mu_i = \mu$. As a result, we obtain a system of equations for the internal nodes of the grids

$$\alpha\varphi_{\tau_{i-1}}^{k+1} - \gamma\varphi_{\tau_i}^{k+1} + \beta\varphi_{\tau_{i+1}}^{k+1} = -\left(f_{x_{i+1}}^{k+1} + f_{x_i}^{k+1}\right)/2, \quad i = \overline{1, N-2}, \quad (5)$$

where $\alpha = a - \frac{A}{2h^2}\mu^2$, $\gamma = a + b + \frac{A}{2h^2}(2h^2 - \mu^2 - (h - \mu)^2)$,

$$\beta = b - \frac{A}{2h^2}(h - \mu)^2, \quad a = \frac{D}{h^2} + \frac{V}{h^2}\mu, \quad b = \frac{D}{h^2} - \frac{V}{h}\left(1 - \frac{\mu}{h}\right), \quad \varphi_i - \text{grid}$$

functions values on grid 4b.

System (5) is some difference scheme written on a three-point pattern. This scheme is monotonous. This follows from the next theorem.

Theorem. Let next condition be satisfied for the grid (4)

$$h \leq 2|V|/A.$$

Then, if $V > 0$ and suggested $\mu > h - \frac{2D}{|V| + \sqrt{V^2 + 2AD}}$, or if $V < 0$ and suggested $\mu < \frac{2D}{|V| + \sqrt{V^2 + 2AD}}$, then the difference principle of maximum is fulfilled for the system (5).

IMAGE THINKING PROCEDURES FOR MATHEMATICAL MODELS BUILDING

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One of the functions of the image thinking is knowhow of operating with structures. In this article we shall analyze such procedures of the image thinking as: set the correspondence between aim and image of the mathematical model (first procedure), find the repeated segments (second procedure), form the structure with some characteristics (third procedure).

As usual we analyze the activity of one system. In this article we deal with two systems: flexible manufacturing shop (system A) and computer subdivision (system B). The main aim is synchronization the activity of two systems. Usage of the first procedure for the aims of the system A has such results:

- the system A must be reliable (first aim) – inventory model,
- the equipment of the system A should have the opportunity to work in the optimal mode (second aim) – optimal model,
- the specialist could diagnose the kind of the breakage in the system A (third aim) – formula.

It is unable to build inventory model because we have not constant demand of any object. For the purpose to realize all aims we create artificial environment with the help of the artificial intelligent procedure “Pendulum”. New images are appeared – corteges of quantum of time.

With the help of the second procedure of the image thinking we found equal corteges consisted of the same quantum. This cortege is the unit of the stock.

With the help of the third procedure of the image thinking we form such instructions for the image of the aim 3:

image of the formula is fraction;
some characteristic must be constant.

Suggested approach gives the opportunity to atomize the process of building of images of models. The path of the parallel calculation of the optimal models is open.

PETRI NETS IN KNOWLEDGE REPRESENTATION AND MODELING OF REASONING: A SOFT SET APPROACH²

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Generalized fuzzy Petri nets (GFPN) [4] have been proposed as a natural extension of the classic fuzzy Petri nets (FPN) [2]. The t-norms were introduced into the GFPN model as substitutes for operators min, max, and * (the algebraic product). This paper describes how the simplified GFPN class, called soft Petri nets (SPN) [1], can be used to represent knowledge and model reasoning in knowledge-based systems (KBS). SPN is based on the soft set theory [3]. SPN is a parameterized graphic representation of the soft production rule in order to solve the imprecise situation in KBS. The soft production rule is used to represent IF-THEN rule, where the predecessor and/or successors are inaccurate information, modeled by a soft set. The truth degree in the initial marking is treated as a binary number and the Boolean operators are used as In, Out₁, Out₂ operators in GFPN. SPN does not include any complex operators as opposed to GFPN. In GFPN, determining the membership function is sometimes unrealistic and is not unique. In backward reasoning, a reversed fuzzy implication is not always possible [5]. SPNs are free from such complications and present lower computational complexity. A numerical example regarding the purchase of real estate is presented to show the practical utility of the approach.

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WAVE BEAM AND WEAKLY ABSORBING RANDOM INHOMOGENEOUS MEDIA

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Wide perspectives of laser applying into systems of optical communication, location, navigation and ranging determined the necessity of rapid predictions of influence of random inhomogeneous media on the laser radiation spreading into the atmosphere and required creation of remote methods of parameter sounding of atmospheric turbulence.

While spreading electromagnetic waves in random inhomogeneous media their amplitude and phase chaotically fluctuate due to turbulent fluctuation of media parameters. As a result, in dielectric permeability ε it is necessary to consider not only refractions values n , but also the imaginary part, determined by the values of absorption μ ; $\sqrt{\varepsilon} = n + i\mu$.

Scattering of electromagnetic waves of megahertz range for the lower layers of the troposphere as a specific model the collisional plasma has been chosen. It is peculiar, that the mutual correlation function is negative for plasma.

Diffraction area, for which the conditions $l_0^2 / \lambda \ll L \ll L_0^2 / \lambda$, i.e. on wave parameter fluctuation is fulfilled, is affected with both inner l_0 , and outer L_0 scale of turbulence. If $L \gg L_0^2 / \lambda$, then for a local homogeneous and isotropic atmospheric turbulence in case of any values of wave figure $\mathcal{N}$ power spectrum of Kolmogorov-Obukhov $\phi_s(\mathcal{N}) = 0,033C_s^2 \mathcal{N}^{-11/3}$ can be used. For applying to this model the formulations for dispersion level and dispersion phase are got. They are expressed through structural functions of parameter fluctuation of

turbulence media which are measured experimentally. For numerical calculations the dimensionless parameter $M=L/R$ is introduced, determining the distance from the source to the observation point within a curvature radius of a phase front at the aperture and $G = L / k\alpha_0^2$ – beam parameter, characterizing the ratio of Frenel zone sizes towards the transverse size of the beam.

IMPACT IONIZATION AND DISPERSION MECHANISM

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Impact ionization allows to specify the dispersion mechanism. It is believed that impact ionization can occur when the electron energy is greater than E_{th} or equal to the energy band gap, which is calculated by the Keldysh formula, derived from the assumption that pulse ionization is determined by the scattering rate on each phonon with the ultimate E_{zR} electron energy.

The dispersion in a strong field is accompanied by the concentration of hot electrons T_e with an elevated temperature of electrons at the deep center of dispersion. This is a fluctuation process. Naturally, the ionization is carried out by electrons with a maximum total energy.

The process of interlinear transition is accompanied by a decrease in the average electron velocity and the formation of domains of strong fields with negative differential conductivity and instability.

Electrons are scattered by large effective masses mainly on the Messer oscillations, ionized impurities and electrical systems of various conductivities. Electron-electron scattering occurs during ionization of excited deep centers in a strong electric field, taking into account heavy and light electrons.

Plots with volt-ampere characteristics of voltage, on which the slope angle was reduced after the previous break, will be clearly visible due to the intense scattering of electrons on optical phonons and electron-electron interaction, with an optimal increase in the number of electrons due to the breakthrough of deep levels that characterize the ionization power.

The paper deals with the determination of the conductivity in a strong electric field by a wide range of deep levels of different density

in a strong electric field. The intersection of recombination of hot electrons is much less than the ionization at the intersection, the substance contains atoms of free electrons.

MAXIMUM LIKELIHOOD ESTIMATION OF THE TRANSITION MATRIX OF THE NON-HOMOGENEOUS MARKOV CHAIN TERRORIST THREAT MODEL

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Markov chain-based models are one of the more popular mathematical tools for modelling time development of risk in various fields of research. The Markov chain is used to govern the change of the risk from one category (state of the chain) to another in discrete time. One particular approach aims to enhance the model by introducing a connection between the Markov chain and some covariates. These covariates describe the development of the environment in which the modelled risk events take place.

The abovementioned approach can be seen for example in [1], where a two state Markov chain non-stationary transition probabilities are connected with a set of covariates through a binomial logit generalized linear model (GLM). The estimation of the transition probabilities is carried out within a maximum likelihood framework while utilizing the said connection. Due to the relative simplicity of the model (two state Markov chain) it is possible to obtain the derivatives of the respective log-likelihood function in a closed form. In security research however models with more than two states are needed. Therefore a generalization of the approach to an arbitrary number of states Markov chain model is necessary. This however complicates the computation of the derivatives significantly.

In this paper a likelihood function for estimation of the transition probabilities of a Markov chain risk model with dependence on given covariates is presented. An approach allowing to bypass the computation of the derivatives in the process of finding the argument of maximum of the likelihood function is presented. This approach relies on using an optimization algorithm that does not require the knowledge of the derivatives. Computational results obtained through simulations are presented. Panel data approach is considered.

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"GOLD" NUMBER IN COMBINATORICS

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As you know, the "gold" number or number of Phidias is present in living nature. This is an irrational number equal to $\Phi=1,618033988749894848204596\dots$ or $\Phi=1,618$. Converse to this number is $\varphi=0,618$. His presence in nature is connected with harmony. The presence of a golden section ("gold" number) in living nature is manifested through the sequence of Fibonacci numbers which looks like 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, If the next number in this sequence is divided into the previous one, then we obtain the number of Phidias, if we divide the preceding number into the next, we obtain the inverse number $\varphi=0,618$. Until the fortieth number the result coincides with the "gold" number.

A sequence of Fibonacci numbers in combinatorics appears when calculating combinatorial configurations in some of their sets that have many orders. Some of them are ordered according to exact rules, others are chaotic. If for a exact ordering, which uses the property of periodicity, to create a sequence of numbers whose sum gives the number of combinatorial configurations in their set, then for some types an arithmetic triangle is formed.

When generating a set of partitions of a number or a set of partitions n -element set on a subset using the property of periodicity, numerical sequences are obtained that specify in them the number of combinatorial configurations, contain Fibonacci numbers, or an arithmetic triangle formed. For example, for a partition of a natural number for $n=7$ a finite sequence, which defines the number of partitions in their set, has the form 1, 3, 4, 3, 2, 1, 1, where the last four digits are the Fibonacci numbers. Using the properties of an arithmetic triangle, one can see that there are also Fibonacci numbers present there.

So ordered combinatorial sets with exact rules contain Fibonacci numbers, respectively, and the "gold" number. This suggests that such sets are characterized by harmony.

BUIDING AN INTEGRATED ARCHITECTURE IN PROGRAM SOFTWARE

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In our study, an attempt was made to group all popular models of architecture and determine their weaknesses and strengths. The study compares models such as Zachman and specialized methodologies that are used in the development of government programs. The results of this study can be used to represent the concept of a complex system in a way that is understandable to business and the customer.

Also, in the work, attempts were made to divide the different methodologies into clusters that make it possible to combine some methodologies to solve more complex issues. The work is valuable for both technical specialists and business analysts who can form their thoughts in a format understandable to the customer. This work provides recommendations for the formation of a comprehensive software architecture as well as recommendations for improving existing architectures. So for example, the Zachman model that is considered in this paper provides the opportunity to build a table whose columns solve critical issues for each complete system. Also, the paper describes new software systems for building scale-out and flexible software systems. The presented methodologies can be taken as a template for building a complete production cycle of the system from planning to implementation.

PRINCIPLES OF THE ORGANIZATION AND APPLICATION SEMINATURAL MODELLING

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Seminatural modelling is a modelling with real equipment at which the system part is modelled, and other part is real. Application of such method of modelling becomes necessary when it is not possible to describe job of some elements of system mathematical. The prompt increase in volumes of the arriving and processed information leads to considerable changes in ways and methods of the analysis of the information and demands introduction of effective methods and intellectual technologies of system of support by the user of decision-making (DSS). The general principles of construction DSS are specified and one of variants of the structural scheme of system for seminatural modelling is offered, the basic problems of construction of the knowledge base are allocated. Methods of the state-of-the-art review and allocation of characteristic signs of seminatural modelling with reference to architecturally-structural organisation DSS and the general principles of construction of system are used. It is thus noticed, that the important making system of seminatural modelling the knowledge base is. Methods of the state-of-the-art review and allocation of characteristic signs of seminatural modelling with reference to architecturally-structural organisation DSS and the general principles of construction of system are used. It is thus noticed, that the important making system of seminatural modelling the knowledge base is. The considered method of construction DSS and its basic properties provide reduction of terms and working out cost especially when DM the decision in real time makes. In the course of seminatural modelling advantages of mathematical and natural modelling are successfully combined and optimum interaction between computing and natural experiments can be reached. Now methods of seminatural modelling effectively apply at designing of various automatic operating systems

DYNAMIC ANALYSIS OF THE POLLUTION DISTRIBUTION IN A HYDROTECHNICAL RAMPART-TERRACE

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Analysis of the dynamics of anthropogenic contaminants in the soil aeration zone is a problem that involves a rather complex numerical implementation of the corresponding evolutionary spatially distributed models. The model considered in [1], in obtaining a numerical solution by means of a constructed economical difference scheme [2], has difficulties arising from the nature of the mathematical equation, from the complexity of boundary conditions, etc. Similar difficulties disappear when using the Finite Element Method (FEM) for the spatial component and the implicit difference scheme for the evolutionary component. So, we develop the ways to solve the problem of mass transfer of a pollutant in a hydrotechnical system of rampart-terrace with a piecewise smooth surface where surface contamination occurred at initial moment. Thus, the model used in our studies is a spatially distributed dynamic model and the goal of its numerical implementation is a dynamic analysis of the distribution of contaminants in the aeration zone of shaft-terraces. The model is as follows [2]:

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

in the area $Q = \Omega \times (0 \leq t \leq T)$, $\Omega \subset R^2$ with piecewise smooth surface $\partial\Omega$, $\varphi(x_1, x_2)$ – the function describing the surface Γ , $\varphi(x_1, x_2) \in L_2(\Omega)$, u_0 – surface contamination, $u(x, t)$ – the concentration of the substance in the point $x = (x_1, x_2) \in \bar{\Omega}$ at the moment t , $D(x)$ – a limited, continuously differentiable function, V – positive constant, $k(\Gamma) = k \cdot \cos(\alpha(\Gamma))$, k – the coefficient of

conductivity (absorption) for surface, $\alpha(\Gamma)$ – the slope of the terrace segment, Γ – piece-smooth surface, q_0 – the flow of water coming from atmospheric precipitation with a substance concentration c_0 .

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

For any $u \in H$ we have: $(Zu, u)_{L_2(Q)} \leq c \|u\|_H^2$; $(Zu, v)_{L_2(Q)} \leq c \|f\|_{L_2(Q)} \|v\|_{L_2(Q)}$.

In [2] also has been shown the existence of a unique generalized solution of this problem in abovementioned spaces.

We offered the use of the FEM with second order elements. That's why we built the grid in area $\bar{\Omega}$ (which corresponds to the segment of length L):

$$\omega = \{x | x = (x_1, x_2), x_1 = \frac{iL}{N} \cos \alpha, i = \overline{0, N+1}, x_2 = \frac{jL}{N} \sin \alpha, j = \overline{0, 2M+N-1}, \\ x_2 = x_1 \tan \alpha + \frac{i2L}{N} \sin \alpha, i = \overline{0, M}, x_2 = -x_1 \tan \alpha + \frac{j2L}{N} \sin \alpha, j = \overline{0, M+N-1}\}.$$

Using the change of variables $x_1 = \psi \cos \alpha, x_2 = H - \chi - \sin \alpha \psi$ we have got the opportunity to proceed to the consideration of a rectangular area $\bar{\Omega}'$, in which we can take MN finite elements. This elements are given by equations $\chi = \frac{2Lj}{N} \sin \alpha, j = \overline{0, M}, \psi = \frac{Li}{N}, i = \overline{0, N}$, it's square is $s_e = \frac{2L^2}{N^2} \sin \alpha$.

Considering second-order quadratic elements, we take nine nodes in each element and, accordingly, nine basic functions. An approximate solution of the problem for each element we represent as a function:

$$u_n^e(t, x) = \sum_{i=1}^9 \alpha_i^e(t) w_i^e(\psi, \chi),$$

where $w_i^e(\psi, \chi)$ - functions of orthonormal basis in $L_2(\Omega)$, consisting of functions from $H(\Omega)$, $\alpha_i^e(t)$ satisfy the following system:

$$(Zu_n^e, w_j^e)_{L_2(\Omega^e)} = (f, w_j^e)_{L_2(\Omega^e)}, j = \overline{1, 9}, t > 0 \quad (1)$$

and initial conditions $\alpha_i^e(0) = 0, i = \overline{1,9}$. In order to take into account the boundary conditions, we consider the system (1) in terms of fulfillment for each element and u_n^e from V_h (for any $v_n^e \in V_h$):

$$\left(\frac{\partial u_n^e}{\partial t} v_n^e + \sum_{i=1}^2 D \frac{\partial u_n^e}{\partial x_i} \frac{\partial v_n^e}{\partial x_i} - \sum_{i=1}^2 V u_n^e \frac{\partial v_n^e}{\partial x_i} - f, v_n^e \right)_{L_2(\Omega^e)} = 0, t > 0.$$

Hence we have:

$$\begin{aligned} & \sum_{i=1}^9 \frac{d\alpha_i^e(t)}{dt} + \int_{\Omega^e} \left(\sum_{k=1}^2 \sum_{i=1}^9 \alpha_i^e(t) D \frac{\partial \omega_i^e(x)}{\partial x_k} \frac{\partial \omega_j^e(x)}{\partial x_k} \right) d\Omega^e - \\ & - \int_{\Omega^e} \left(\sum_{k=1}^2 \sum_{i=1}^9 V \alpha_i^e(t) \omega_i^e(x) \frac{\partial \omega_j^e(x)}{\partial x_k} + f \omega_j^e(x) \right) d\Omega^e = 0, j = \overline{1,9}, \\ & \alpha_i^e(0) = 0, i = \overline{1,9}. \end{aligned}$$

We write this system of equations in the following form:

$$\begin{aligned} & \sum_{i=1}^9 \frac{\alpha_i^{k+1e} - \alpha_i^{ke}}{\tau} + \sum_{i=1}^9 \alpha_i^{k+1e} \Lambda_{ij}^e = f_j^{ke}, j = \overline{1,9}, \\ & \alpha_i^{0e} = 0, i = \overline{1,9}. \end{aligned}$$

where

$$\begin{aligned} \Lambda_{ij}^e &= \int_{\Omega^e} \left(\sum_{k=1}^2 D \frac{\partial \omega_i^e(x)}{\partial x_k} \frac{\partial \omega_j^e(x)}{\partial x_k} - \sum_{k=1}^2 V \omega_i^e(x) \frac{\partial \omega_j^e(x)}{\partial x_k} \right) d\Omega^e, i, j = \overline{1,9}, \\ f_j^e &= \int_{\Omega^e} f \omega_j^e(x) d\Omega^e, j = \overline{1,9}. \end{aligned}$$

For the constructed numerical approximation convergence to the generalized solution was considered. Taking into account the above inequalities, it was shown that for any function $u \in H$ there exists a sequence of functions u_n^e from V_h , such that $\lim_{h \rightarrow 0} \|u - u_h\|_{W_2^1(\Omega)} \rightarrow 0$,

where h is the diameter of elements ($h = \frac{L}{N} \sqrt{1 + 4 \sin^2 \alpha}$, L - length of the rampart-terrace component with a slope α).

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MATHEMATICAL AND COMPUTER MODELING OF THE INTERCONNECTED PROCESSES MOISTURE AND HEAT AND MASS TRANSFER IN ONE-DIMENSIONAL CASE

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The interconnected processes are considered of moisture and heat and mass transfer in horizontal non-saturated soil mass.

The mathematical model of this problem in generally adopted specifications may be described by the following boundary value problem:

$$\frac{\partial}{\partial x} \left(D(c, \Theta, T) \frac{\partial c}{\partial x} \right) - v(c, \Theta, T) \frac{\partial c}{\partial x} - \gamma(c - C^*) + \frac{\partial}{\partial x} \left(D_T \frac{\partial T}{\partial x} \right) = \frac{\partial(\Theta c)}{\partial t},$$

$$\frac{\partial}{\partial x} \left(K(c, h, T) \frac{\partial h}{\partial x} \right) - \frac{\partial}{\partial x} \left(v \frac{\partial c}{\partial x} \right) - \frac{\partial}{\partial x} \left(v^T \frac{\partial T}{\partial x} \right) + f = \mu(h) \frac{\partial h}{\partial t},$$

$$\frac{\partial}{\partial x} \left(\lambda_T \frac{\partial T}{\partial x} \right) - \rho C_p v \frac{\partial T}{\partial x} = C_T \frac{\partial T}{\partial t}, \quad x \in (0; l), \quad t > 0,$$

$$v = -k(c, h, T) \frac{\partial h}{\partial x} + v \frac{\partial c}{\partial x} + v_T \frac{\partial T}{\partial x}, \quad x \in (0; l), \quad t > 0,$$

$$c(x, 0) = C_0(x), \quad l_1 c(0, t) = C_1(t), \quad l_2 c(l, t) = C_2(t), \quad x \in (0; l), \quad t > 0,$$

$$h(x, 0) = H_0(x), \quad h(0, t) = H_1(t), \quad h(l, t) = H_2(t), \quad x \in (0; l), \quad t > 0,$$

$$T(x, 0) = T_0(x), \quad T(0, t) = T_1(t), \quad T(l, t) = T_2(t),$$

The numerical solution of this problem is found by a method of finite differences using the monotonic scheme. Software was created on the basis of developed algorithms and a series of numerical experiments were done. As a result of the programming implementation on C++ of the problem the distribution was found of the field of the concentration of salt and heat and moisture solutions.

MATHEMATICAL MODELING OF MIGRATION PROCESSES OF POPULATION IN ONE-DIMENSIONAL CASE

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The specifics of the current stage of society connects with significant changes in directions and internal scales and interstate migration of the population.

In this regard population migration processes between the two states are exploring in a one-dimensional case.

Now the scientific literature offers different mathematical models of these processes [1-3]. However, we will use diffusion models for modeling these processes. In particular mathematical model of this problem in a one-dimensional case in conventional notation can be described by the following boundary value problem:

$$D_1 \frac{\partial^2 c_1}{\partial x^2} - v_1 \frac{\partial c_1}{\partial x} - \gamma_1 c_1 = \frac{\partial c_1}{\partial t}, \quad (1)$$

$$D_2 \frac{\partial^2 c_2}{\partial x^2} - v_2 \frac{\partial c_2}{\partial x} - \gamma_2 c_2 = \frac{\partial c_2}{\partial t}, \quad (2)$$

$$c_1(x, 0) = \tilde{C}_0^1(x), \quad x \in (0, a_1), \quad (3)$$

$$c_2(x, 0) = \tilde{C}_0^2(x), \quad x \in (a_1, a), \quad (4)$$

$$l_1 c_1(0, t) = \tilde{C}_1(t), \quad t > 0, \quad (5)$$

$$l_2 c_2(a, t) = \tilde{C}_2(t), \quad t > 0, \quad (6)$$

$$l_3(c_1(a, t), c_2(a, t)) = \tilde{C}_3(t), \quad t > 0, \quad (7)$$

$$l_4(q_1(a, t), q_2(a, t)) = \tilde{C}_4(t), \quad t > 0. \quad (8)$$

where $c_i = c_i(x, t)$, $q_i = q_i(x, t)$, $i = 1, 2$ is concentrations and flows of population, v_i , $i = 1, 2$ is population migration speed, (2), (3) – determines the initial conditions for population concentrations, D_1, D_2 – population diffusion coefficients; l_i , $i = 1, 2$ – operators which determines boundary conditions for concentrations c_1 and c_2 at the ends of the segment $(0, a)$, l_i , $i = 3, 4$ – operators which determines

conditions of unification for concentrations and population flows at the point $x = a$.

For solving the boundary value problem (1) - (8) it is constructed monotonic difference scheme and founded its numerical solution [4]. Also there is developed software and conducted experiments. We can improve the quality of analysis of the state of the migration system, to model and predict population migration based on the proposed model of studies of migration processes.

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MATHEMATICAL MODELING OF THE PROSESSES OF NON-ISOTHERMAL MOISTURE AND MASS TRANSFER DURING MICROIRRIGATION IN HORIZONTAL SOIL LAYER

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The process is considered of moisture transfer and heat and mass transfer during microirrigation in horizontal non-saturated soil mass.

The mathematical model of this problem in generally adopted specifications in domains $\Omega_i(t)$, $i = 1, 2$ may be described by the following boundary value problem:

$$\frac{\partial(DT(c_i)\frac{\partial c_i}{\partial x})}{\partial x} - v_i \frac{\partial c_i}{\partial x} - \gamma_i(c_i - C_i^*) + D_{T_i} \frac{\partial^2 T_i}{\partial x^2} = \frac{\partial(\Theta_i c_i)}{\partial t}, \quad (1)$$

$$\mu_i(h_i) \frac{\partial h_i}{\partial t} = \frac{\partial}{\partial x} \left(k_i(c_i, h_i, T_i) \frac{\partial h_i}{\partial x} \right) - v_i \frac{\partial^2 c_i}{\partial x^2} - v_i^T \frac{\partial^2 T_i}{\partial x^2}, \quad (2)$$

$$\lambda_i \frac{\partial^2 T_i}{\partial x^2} - \rho_i v_i c_p^i \frac{\partial T_i}{\partial x} = c_T^i \frac{\partial T_i}{\partial t}, \quad (3)$$

$$v_i = -k_i(c_i, h_i, T_i) \frac{\partial h_i}{\partial x} + v_i(c_i) \frac{\partial c_i}{\partial x} + v_i^T \frac{\partial T_i}{\partial x}, \quad (4)$$

$$c_1(0, t) = \widetilde{C}_1(t), c_2(l, t) = C_2(t), c_i(x, 0) = C_0^i(x), \quad (5)$$

$$h_i(x, 0) = H_0^i(x), h_1(0, t) = H_1(t), h_2(l, t) = H_2(t), \quad (6)$$

$$T_i(x, 0) = T_0^i(x), T_1(0, t) = T_1(t), T_2(l, t) = T_2(t), \quad (7)$$

$$[c] = [T] = \left[v c - D \frac{\partial c}{\partial x} \right] = [h] = 0, x = l(t). \quad (8)$$

The numerical solution of this boundary value problem (1)-(8) is found by a method of finite differences using the monotonic scheme.

ABOUT MATHEMATICAL MODELING OF INFLUENCE OF HEAT AND MASS TRANSFER IN NON-STATIONARY FILTRATION DEFORMATION PROCESSES OF SOIL MASSIF

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Considered a soil massif with thickness l in the conditions of heat and mass transfer during filtration of salt solutions in non-isothermal conditions (see Fig. 1).

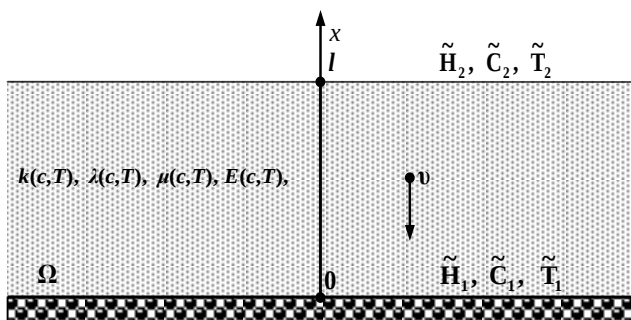


Fig. 1. The scheme of the soil massif under heat and mass transfer

The mathematical model of the set problem in general accepted notation can be described as the next one-dimensional boundary value problem (1)-(12) [1-2]:

Lame equation describing the stressed-strained state of the soil massif for displacement $U(x, t)$ with account for the heat and mass transfer in it:

$$\begin{aligned} & (\lambda(c, T) + 2\mu(c, T)) \frac{\partial^2 U}{\partial x^2} + \frac{\partial(\lambda(c, T) + 2\mu(c, T))}{\partial x} \frac{\partial U}{\partial x} - \left(\frac{\partial(\lambda(c, T) + 2\mu(c, T))}{\partial x} T + \right. \\ & \left. + (\lambda(c, T) + 2\mu(c, T)) \frac{\partial T}{\partial x} \right) \alpha_T + X = \frac{\partial^2 U}{\partial t^2}, \quad x \in (0, l), \quad t > 0, \end{aligned} \quad (1)$$

where component of mass force is calculated by the formula

$$X = \gamma_{zv} + \frac{dp}{dx}, \quad x \in (0; l), \quad (2)$$

the equation of convective diffusion in the presence of heat and mass transfer

$$\frac{\partial}{\partial x} \left(D(c, T) \frac{\partial c}{\partial x} \right) - v \frac{\partial c}{\partial x} - \gamma(c - C_m) + \frac{\partial}{\partial x} \left(D_T \frac{\partial T}{\partial x} \right) = n_p \frac{\partial c}{\partial t}, \quad x \in (0; l), \quad t > 0, \quad (3)$$

the convective heat transfer equation

$$\frac{\partial}{\partial x} \left(\lambda_T \frac{\partial T}{\partial x} \right) - \rho c_p v \frac{\partial T}{\partial x} = c_T \frac{\partial T}{\partial t}, \quad x \in (0; l), \quad t > 0, \quad (4)$$

the generalized Darcy-Grisevanov law in the case of motion of salt solution in the presence of a temperature gradient and the continuity equation

$$\nu = -K(c, T) \frac{\partial h}{\partial x} + \nu_c(c) \frac{\partial c}{\partial x} + \nu_T \frac{\partial T}{\partial x}, \quad \frac{\partial \nu}{\partial x} + \frac{\partial n_p}{\partial t} = 0, \quad x \in (0; l), \quad t > 0, \quad (5)$$

the strain and stress are calculated by the formulas

$$\varepsilon = \frac{\partial U}{\partial x}, \quad \sigma = (\lambda(c, T) + \mu(c, T))(\varepsilon - \alpha_T \bar{T}), \quad x \in (0, l), \quad t > 0, \quad (6)$$

with appropriate boundary conditions for displacement $U(x, t)$, piezometric head $h(x, t)$, concentration of salt solution $c(x, t)$ and temperature $T(x, t)$

$$l_1 U(0, t) = 0, \quad l_2 U(l, t) = 0, \quad t > 0, \quad (7)$$

$$l_3 c(0, t) = \tilde{C}_1(t), \quad l_4 c(l, t) = \tilde{C}_2(t), \quad t > 0, \quad (8)$$

$$l_5 T(0, t) = \tilde{T}_1(t), \quad l_6 T(l, t) = \tilde{T}_2(t), \quad t > 0, \quad (9)$$

$$l_7 h(0, t) = \tilde{H}_1, \quad l_8 h(l, t) = \tilde{H}_2, \quad t > 0, \quad (10)$$

$$U(x, 0) = \tilde{U}_0^{(1)}, \quad \frac{\partial U(x, 0)}{\partial t} = \tilde{U}_0^{(2)}, \quad x \in (0, l), \quad (11)$$

$$c(x, 0) = \tilde{C}_0(x), \quad T(x, 0) = \tilde{T}_0(x), \quad h(x, 0) = \tilde{H}_0(x), \quad x \in (0, l). \quad (12)$$

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OPTIMAL CONTROL PROBLEM WITH THE BOUNDARY FUNCTIONAL FOR A SCHRÖDINGER EQUATION WITH A SPECIAL GRADIENT TERM

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We consider the problem of finding the minimum of functional

$$J_{\alpha}(v) = \|\psi - y\|_{L_2(S)}^2 + \alpha \|v - \omega\|_H^2 \quad (1)$$

on the set of admissible controls

$$V = \{v = v(x) = (v_0(x), v_1(x)) : v_m \in W_2^1(D),$$

$$|v_m(x)| \leq b_m, \left| \frac{\partial v_m(x)}{\partial x_k} \right| \leq d_m, k = 1, n, m = 0, 1, \forall x \in D \}$$

under conditions:

$$i \frac{\partial \psi}{\partial t} + a_0 \Delta \psi + ia_1(x) \nabla \psi - a(x) \psi + v_0(x) \psi + iv_1(x) \psi = f(x, t), (x, t) \in \Omega, \quad (2)$$

$$\psi(x, 0) = \varphi(x), x \in D, \frac{\partial \psi}{\partial \nu} \Big|_S = 0, \quad (3)$$

where $i = \sqrt{-1}$ imaginary unit, $T > 0$, $b_m > 0$, $d_m > 0$, $m = 0, 1$, $a_0 > 0$, $\alpha \geq 0$ are given numbers, $D \in R^n$ is a convex bounded

domain, $\Delta = \frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2} + \dots + \frac{\partial^2}{\partial x_n^2}$ – Laplace operator,

$\nabla = \left(\frac{\partial}{\partial x_1}, \frac{\partial}{\partial x_2}, \dots, \frac{\partial}{\partial x_n} \right)$ – nabla operator, $x \in D$, $0 \leq t \leq T$,

$\Omega_t = D \times (0, t)$, $\Omega = \Omega_T$, $S \equiv \Gamma \times (0, T)$, Γ – is boundary of domain D ,

ν – outward normal of boundary Γ ; $\psi = \psi(x, t)$ – is wave function;

$a(x), a_1(x)$ are measurable bounded real-valued functions that satisfy the conditions:

$$0 < \mu_0 \leq a(x) \leq \mu_1, \left| \frac{\partial a(x)}{\partial x_k} \right| \leq \mu_2, k=1, n, \forall x \in D, \mu_0, \mu_1, \mu_2 = \text{const} > 0, \quad (4)$$

$$|a_{1j}(x)| \leq \mu_3, \left| \frac{\partial a_{1j}(x)}{\partial x_k} \right| \leq \mu_4, j, k=1, n, a_1|_{\Gamma} = 0, \forall x \in D, \mu_3, \mu_4 = \text{const} > 0; \quad (5)$$

$\varphi(x), f(x, t), y(x)$ are given complex-valued functions satisfying the conditions:

$$\varphi \in W_2^2(D), \left. \frac{\partial \varphi}{\partial \nu} \right|_{\Gamma} = 0, \quad f \in W_2^{0,1}(\Omega), \quad y \in L_2(S); \quad (6)$$

$\omega \in H$ is a given element, $H \equiv W_2^1(D) \times W_2^1(D)$ and the symbol $\overset{0}{\forall}$ means “for almost everywhere”.

In this paper, the existence and uniqueness of solution of considered optimal control problem is investigated and a necessary optimality condition in variational inequality form for its solution is obtained [1].

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IDENTIFICATION PROBLEM FOR THE LINEAR NONSTATIONARY QUASI OPTICS EQUATION WITH A SQUARE SUMMABLE COEFFICIENTS

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We consider the identification problem for the linear nonstationary quasi optics equation with square summable coefficients of finding the minimum of functional:

$$J_{\alpha}(v) = \|\psi - y\|_{L_2(\Omega)}^2 + \alpha \|v - \omega\|_H^2 \quad (1)$$

on the set:

$$V \equiv \left\{ v = (v_0, v_1), v_m \in L_2(0, l), \|v_m\|_{L_2(0, l)} \leq b_m, \right. \\ \left. m = 0, 1, v_1(x) \geq \tilde{b}_1, \forall x \in (0, l) \right\}$$

under conditions:

$$i \frac{\partial \psi}{\partial t} + i a_0 \frac{\partial \psi}{\partial z} - \frac{\partial}{\partial x} \left(a_1(x) \frac{\partial \psi}{\partial x} \right) + a(x) \psi \\ + v_0(x) \psi + i v_1(x) \psi = f(x, t, z), \quad (x, t, z) \in \Omega, \quad (2)$$

$$\psi(x, 0, z) = \varphi_0(x, z), \quad (x, z) \in \Omega_L, \quad (3)$$

$$\psi(x, t, 0) = \varphi_1(x, t), \quad (x, t) \in \Omega_T, \quad (4)$$

$$\psi(0, t, z) = \psi(l, t, z) = 0, \quad (t, z) \in Q, \quad (5)$$

where $i = \sqrt{-1}$ – imaginary unit, $l > 0$, $T > 0$, $L > 0$, $a_0 > 0$, $\alpha > 0$, $b_1 > 0$, $b_2 > 0$, $\tilde{b}_1 > 0$ are given numbers, $0 \leq x \leq l$, $0 \leq t \leq T$, $0 \leq z \leq L$, $\Omega_{tz} = (0, l) \times (0, t) \times (0, z)$, $\Omega = \Omega_{TL}$, $Q = (0, T) \times (0, L)$; $\psi(x, t, z)$ is a wave function, $a_1(x), a(x)$ are measurable real-valued functions that satisfy the conditions:

$$\mu_0 \leq a_1(x) \leq \mu_1, \quad \forall x \in (0, l), \quad \mu_0, \mu_1 = \text{const} > 0, \quad (6)$$

$$\left| \frac{da_1(x)}{dx} \right| \leq \mu_2, \quad \forall x \in (0, l), \quad \mu_2 = \text{const} > 0, \quad (7)$$

$$0 \leq a(x) \leq \mu_3, \quad \forall x \in (0, l), \quad \mu_3 = \text{const} > 0; \quad (8)$$

$y(x, t, z)$, $f(x, t, z)$, $\varphi_0(x, z)$, $\varphi_1(x, t)$ are given complex-valued functions satisfying the conditions:

$$y \in L_2(\Omega), \quad f \in W_2^{0,0,1}(\Omega), \quad \varphi_0 \in W_2^{2,1}(\Omega_L), \quad \varphi_1 \in W_2^{2,1}(\Omega_T); \quad (9)$$

$\omega = (\omega_0, \omega_1) \in H \equiv L_2(0, l) \times L_2(0, l)$ is given element, the symbol $\forall$ means “for almost everywhere”.

In this paper, the existence and uniqueness of solution of considered identification problem is investigated and a necessary condition in variational inequality form for its solution is obtained [1,2].

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OPTIMAL CONTROL PROBLEM FOR FINANCIAL FLOWS SHOWN WITH STATE OF SPECIAL LINEAR SYSTEMS

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In this paper, the following problem of optimal control of financial flows is considered. The functional needs to be minimized:

$$J_{\alpha}(u) = \sum_{l=1}^m \|x^l - y^l\|_{L_2^{(n)}(0,T)}^2 + \alpha \|u - \omega\|_{L_2^{(m)}(0,T)}^2 \quad (1)$$

on the set:

$$U \equiv \left\{ u = u(t) : u \in L_2^{(m)}(0,T), \|u\|_{L_2^{(m)}(0,T)} \leq b_0 \right\}$$

under the conditions:

$$\dot{x}^l(t) = A^l(t)x^l(t) + B^l(t)u(t) + f^l(t), \quad l = \overline{1, m}, \quad 0 \leq t \leq T, \quad (2)$$

$$x^l(0) = x_0^l, \quad l = \overline{1, m}, \quad (3)$$

where $T > 0$ – given moment of time; $\alpha \geq 0, b_0 > 0$ – given numbers and $\omega = \omega(t) = (\omega_1(t), \omega_2(t), \dots, \omega_m(t))$ – a pre-planned financial flow vector at the time t ; $y^l = y^l(t) = (y_1^l(t), y_2^l(t), \dots, y_n^l(t))$, $y_j^l(t)$ – pre-planned financial flow received by the j -client from the l -financial flow of the bank at time t ; $x_0^l = (x_{01}^l, x_{02}^l, \dots, x_{0n}^l)$, $x_{0j}^l, j = \overline{1, n}$ – specified numbers describing the initial state of the financial flow in the enterprise; $u = u(t) = (u_1(t), u_2(t), \dots, u_m(t))$, $u_l(t), l = \overline{1, m}$ – financial flow of the l -source of finance at the time point t ; $x^l = x^l(t) = (x_1^l(t), x_2^l(t), \dots, x_n^l(t))$, $y_j^l(t), j = \overline{1, n}$ – the financial flow received by the j -client from the bank from the l -financial flow at the time point t ; $A^l(t) = \{a_{ij}^l(t)\}, i, j = \overline{1, n}$, and

$B^l(t) = \{b_{jk}^l(t)\}, j = \overline{1, n}, k = \overline{1, m}, \quad l = \overline{1, m}$ – given matrices;

$f^l = f^l(t) = (f_1^l(t), f_2^l(t), \dots, f_n^l(t)), \quad l = \overline{1, m}$ – given functions.

Matrices of $A^l(t)$, $B^l(t)$ and vector-functions of $f^l(t)$, $l = \overline{1, m}$ are determined by the internal laws of financial process in the enterprise.

The elements of matrices of $A^l(t)$ and $B^l(t)$, $l = \overline{1, m}$ – are measurable limited functions and the elements of vector-functions $f^l(t)$, $l = \overline{1, m}$ – are the quadratic integrable functions.

In this paper, the existence and the uniqueness theorems for solving optimal control problem (1) – (3) are proved. The necessary and sufficient conditions for the solution of the problem are shown [1].

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NECESSARY AND SUFFICIENT CONDITIONS FOR THE SOLUTION OF THE LARGE DEVIATIONS PRINCIPLE IN THE SCHEMES OF NONLINEAR APPROXIMATIONS

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The large deviation principle arose as a method of solving statistical problems associated with the probability of a rare event. In [1,2] the large deviation principle in the scheme of nonlinear Poisson approximation and Levi approximation is investigated and representation of generators for processes with independent increments are found. The purpose of this work is to find the necessary and sufficient conditions for the solution of the large deviation principle.

Consider the process with independent increments

$$\eta_3^\varepsilon(t) = g_1(\varepsilon) \eta\left(\frac{t}{g_2(\varepsilon)}\right),$$

where $g_1(\varepsilon), g_2(\varepsilon) \rightarrow 0$ when $\varepsilon \rightarrow 0$.

These processes are defined by generators

$$\Gamma_3^\varepsilon \varphi(u) = (g_2(\varepsilon))^{-1} \int_R [\varphi(u + g_1(\varepsilon)v) - \varphi(u)] \Gamma^\varepsilon(dv).$$

The solution of the large deviation principle in the scheme of Poisson approximation under conditions P1-P5 [2] exists and this solution are determined by the limiting generator H_{Γ_1}

$$H_{\Gamma_1} \varphi(u) = b\varphi'(u) + \int_R (e^{v\varphi'(u)} - 1 - v\varphi'(u)) \Gamma^0(dv)$$

if and only if, when the condition is fulfilled

$$(g_2(\varepsilon))^{-1} g_1(\varepsilon) f_1(\varepsilon) \rightarrow 1, \varepsilon \rightarrow 0.$$

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SENSORS AND DATA FUSION: MODELING, INFORMATION ASSESMENT AND DECISION MAKING

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This report focuses on how to make the right decision in space in high pressure environments including gravitation field. Understanding how gravity impacts the way in which we make decisions has never been more pressing. This report also concentrates on the problem of designing and developing optical-cryogenic gravimeter using optimization techniques, modeling, and new materials. The report serves as a companion text to courses taught by the author on multisensor, multitarget data fusion techniques for tracking and identification of potential targets. Material regarding the benefits of multisensor systems and data fusion originally developed for courses on advanced sensor design for defense applications was utilized in preparing the original edition. Those topics that deal with applications of multiple sensor

systems; target, background, and atmospheric signature-generation phenomena and modeling; and methods of combining multiple sensor data in target identity and tracking data fusion architectures were expanded for this book. Most signature phenomena and data fusion techniques are explained with a minimum of mathematics or use relatively simple mathematical operations to convey the underlying principles. Understanding of concepts is aided by the nonmathematical explanations provided in each chapter. Multisensor systems are frequently designed to overcome space limitations associated with smart weapons applications or to combine and assess information from noncollated or dissimilar sources. Packaging volume restrictions associated with the construction of fire-and-forget missile systems often constrain sensor selection to those operating at infrared and millimeter-wave frequencies. In addition to having relatively short wavelengths and hence occupying small volumes, these sensors provide high resolution and complementary information as they respond to different signature-generation phenomena. The result is a large degree of immunity to inclement weather, clutter, and signature masking produced by countermeasures. Sensor and data fusion architectures are utilized in these multisensor systems to combine information from the individual sensors and other sources in an efficient and effective manner. Chapters 2 - 11 discuss the benefits of infrared and millimeter-wave sensor operation including atmospheric effects; multiple sensor system applications; definitions and examples of data fusion architectures and algorithms; classical inference, which forms a foundation for the more general Bayesian inference and Dempster-Shafer evidential theory that follow in succeeding chapters; artificial neural networks; voting logic as derived from Boolean algebra expressions; fuzzy logic; detecting and tracking objects using only passively acquired data; and a summary of the information required to implement each of the data fusion methods discussed. Weather forecasting, Earth resource surveys that use remote sensing, vehicular traffic management, target classification and tracking, and battlefield assessment are some of the applications that will benefit from the discussions provided of signature-generation phenomena, sensor fusion architectures, and data fusion algorithms. There continues to be high interest in military and homeland defense usage of data fusion to assist in the identification of missile threats, suicide bombers, strategic and tactical targets, assessment of information, evaluation of potential responses to a threat, and allocation of resources. The signature- generation phenomena and fusion architectures and

algorithms presented in this book continue to be applicable to these areas as well as the growing number of nondefense applications.

ESTIMATE OF LIMIT SEMI-CONTINUOUS KILLED MARKOV DECISION PROCESS

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We consider a sequence of semi-continuous killed Markov decision processes [1] Z_μ which satisfies the following conditions:

1. set of states $X = \bigcup_{t=m}^n X_t$ is a separable metric space;
2. set of all pairs $xx (x \in X_t)$ belongs $\sigma(X_t \times X_t)$;
3. subset of killed states $X^* \subset X$ is measurable;
4. $X_m, X_{m+1}, \dots, X_n$ are disjoint subsets of X ;
5. sets $X_m \cap X^*, X_m \setminus X^*, \dots, X_n \cap X^*, X_n \setminus X^*$ are closed subsets of X ;
6. set of controls $A = \bigcup_{t=m+1}^n A_t$ is a separable metric space
7. $A_{m+1}, A_{m+2}, \dots, A_n$ are disjoint closed subsets of A ;
8. correspondence $A(x)$ is quasicontinuous (if $x_k \rightarrow x \in X$ and $a_k \in A(x_k)$, then $\{a_k\}$ has a limit point belonging to $A(x)$);
9. if $f \in \mathcal{E}(X_t)$ [1] and $g(a) = \int_{X_t} p(dx|a) f(x) (a \in A_t)$, then

$$g \in \mathcal{E}(A_t);$$

And analyze the sufficient conditions of existence of the estimate [2] of limit process. As well as we show that the estimate of the limit process $Z^* \equiv (X, A, j, p, q^*, r^*, c^*)$ is equal to the limit of estimates of Z^k .

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