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MYKHAILO BARTISH 80th ANNIVERSARY

Mykhailo Yaroslavovych Bartish was born on March 1, 1941 in the village of Sokolivka, Busk district, Lviv region. He became interested in mathematics in his early school years. Therefore, in 1957 he enrolled to the Faculty of Mechanics and Mathematics of Ivan Franko State University of Lviv. Already in his student years he began to be actively engaged in scientific work and after graduating from the university he remained to work as an assistant at the Department of Computational Mathematics. In 1964, Mykhailo Yaroslavovych entered the graduate school of the Institute of Mathematics of the USSR Academy of Sciences, where in 1968 he defended his dissertation under the supervision of V.E. Shamansky. His dissertation was devoted to numerical methods for solving nonlinear boundary value problems for ordinary differential equations.

After the successful defense of his dissertation, Mykhailo Yaroslavovych came back to work at Lviv University, where he continues to work till this day. He worked for 38 years as the Head of the Department of the Theory of Optimal Processes. M.Bartish was one of the initiators of the establishment in 1975 of the Faculty of Applied Mathematics and Mechanics. He was the Dean of this faculty in 1987-1988 and in 1988-1996 - Dean of the Faculty of Applied Mathematics and Informatics.

In 2003 he defended his doctor of sciences thesis on "Newton-type methods for solving nonlinear operator equations and extremum problems." In 2005, Mykhailo Yaroslavovych was awarded the academic title of professor. For active scientific and pedagogical activity in 2015 he was awarded the title of Honored Professor of Ivan Franko National University of Lviv.

Under the leadership of Prof. Bartish at the Department of Theory of Optimal Processes there was formed a scientific school for solving nonlinear functional equations and extremum problems. Most of his research is devoted to the development of new methods for solving such problems. In his scientific papers new approaches to the construction and study of methods with superlinear convergence for solving specific classes of problems have been suggested. For more than 30 years he managed the implementation of state-funded and commercial contract projects together with scientific, design and engineering institutions and industrial enterprises of Lviv, Kyiv, Tallinn, Moscow and others. Under the supervision of Prof. Bartish 8 PhD dissertations and 2 doctoral dissertations were defended.

Prof. Bartish is a highly regarded scientist. For many years he has been a member of specialized councils, a member of the editorial board of different journals, a member of the organizing committees of scientific conferences, in particular, PDMU. That is why since 2007 he has been a member of the Expert Council for the Examination of Dissertations of the Higher Attestation Commission, later the State Audit Office of the Ministry of Education and Science of Ukraine. In 1986 he was awarded the badge of honor "Excellence in Education of Ukraine", since 2009 - Academician of the Academy of Higher School of Ukraine. He is a laureate of the Yaroslav Mudryi award of the Academy of Higher School of Ukraine since 2011, Honored Worker of Education of Ukraine since 2016.

Mykhailo Yaroslavovych's teaching activity is closely connected with his scientific activity. His training courses are defined by scientific interests - these are courses of optimization methods, operations research, mathematical economics. Prof. Bartish is the author of more than 200 scientific and education-methodical works, including textbooks and manuals with the stamp of the Ministry of Education and Science of Ukraine, in particular, a series of textbooks "Operations Research" in 5 parts (co-authored with I.M. Dudzyanyy).

Professor Bartish M.Ya. is well-respected among students, teachers and the scientific community.

The Organizing Committee of the International Conference PDMU-2021 sincerely congratulates Professor M.Ya. Bartish with his anniversary, wishes good health, longevity and conquest of new scientific heights.

CONTENT[1]

Abashidze I. Types of measurements of the traffic flow characteristics 12

Akhvlediani N. The importance of student autonomy in teaching foreign languages..... 13

Bagrationi I. The impact of worldview theory on the decision-making process in business education..... 14

Bakhrushin V. Data inconsistancy and COVID-19 pandemic predicting 16

Bakuridze M., Bakuridze A. Some approximate properties of cesaro means fourier series and their conjugates 17

Bartish M.Ya., Kovalchuk O.V., Ogorodnyk N.P. The idea of constructing a general method for minimization function of many variables with over the quadratic order of convergence 19

Beyko I., Furtel O. To construction of generalized solutions of control systems..... 20

Beyko I., Spivak Ju. Combined global minimization algorithms 21

Bieda I., Kysil A., Shevchenko V. An approach for the scene change localisation 22

Bomba A., Baranovsky S., Lyashko S., Pryshchepa O. Modeling development of infectious disease in conditions of concentrated influences taking into account diffusion perturbations and convection..... 23

Bratiichuk M., Chechelnitsky A., Usar I. Finite M/M/1 retrial models with changeable service rate..... 24

Chabanyuk Ya, Nikitin A., Khimka U. The compensating operator of the diffusion transfer process in the control task 25

Chachanidze G. Formalized representation of student mobility decision-making 26

Chachanidze N. A systematic approach to student mobility decision-making 27

[1] *The abstracts are publishing in authors edition*

Chaika D. An approach to postoptimality analysis of multiobjective linear optimization problem with binary variables..... 28

Cherniy D., Pichkur V., Vasin P., Voloshchuk S., Zloschastiev D. Method and algorithm for converting expressions from discretized singular integrals 29

Chikrii G. Principle of time stretching in game dynamic problems.... 31

Didmanidze I., Didmanidze M., Imnaishvili G. Principles of a systems approach in modeling..... 32

Didmanidze I., Motskobili Ia, Didmanidze M., Didmanidze T., Zakaradze Z. Prerequisites for the task of forecasting the demand for specialists in the region 33

Didmanidze I., Tsitskishvili G., Kutchava M. Cargo shipping planning and integrated information technology system 34

Didmanidze I.Sh., Zoidze K.M., Putkaradze N.M., Didmanidze D.Z. Education and computer technology 35

Dyyak I. Reliable FEM schemes for elasticity problem based on FEM-BEM error estimators 36

Dzhoha A., Lebedev E. Sequential resource allocation under multi-armed bandit model with delays..... 36

Eresko V., Vyshinskiy V., Vyshinska O., Kononenko O., Slipets A. About the virtualization of components of modern computer systems for scientific researches and semi-natural modeling..... 37

Ilienko V.V. Decision-making under conditions of uncertainty with a fuzzy set of environment states according to Wald's criterion 38

Ivohin E., Adzhubey L., Naumenko Yu. About fractional analysis for hybrid modeling of information distribution processes 39

Kakashvili G. Information support structure for mobility decision-making 40

Kapustian O. A., Nakonechnyi O. G., Podlipenko Y. K. Guaranteed estimation of right-hand sides of first order linear periodic ODEs from indirect observations with deterministic and noisy errors..... 42

Kashpur O. F. The interpolation problem and system of nonlinear equations in Euclidean spaces..... 43

Kasradze G. Investment solutions with Greenfield and Brownfield in Georgia..... 44

Kasradze G. The role of the investment decision in the investment process 46

Kiktev N. The concept of the intelligent automated system for diagnostics of the quality of electric power..... 48

Kinash Y., Melnychyn A. Complementing of the salesman's problem with additional conditions 49

Korolchuk S., Melnychyn A. Heuristic evaluation as a tool for quality control of user interface in an electronic document management system 50

Kotelnikova V., Iksanov A. A functional limit theorem for nested Karlin's occupancy scheme generated by Weibull-like distributions... 52

Koval V.V., Lysenko V.P., Samkov O.V., Kazakova N.F., Osinskii O.L., Yakymenko I.Yu., Duk V.A. Automated system of multi-channel telemonitoring of time synchronization signals of electric power networks of smart-technologies 53

Kovalenko O. Yu. Optimal transport algorithms and Wasserstein barycenters 54

Krak Iu., Kasianiuk V., Kudin H. On the piecewise hyperplane clustering method for solving recognition problems 55

Kravets A.V., Semenov V.V. Randomized block algorithms for variational inequalities 56

Kulian V., Yunkova O. Parametric identification of assets dynamics models..... 57

Kurzantseva L. On the question of implementation of the information security unit of the user interface for semi-natural modeling systems..... 58

Kvlividze N. Information model of procurement decision-making support algorithm..... 59

Livinska H. On moments of multi-channel queueing networks with periodic input..... 61

Lyubchyk L., Grinberg G., Yamkovyi K. Learning to rank on aggregated data in real time 62

Makushenko I., Usar I. About optimal threshold strategies for stochastic systems with queue and repeated calls 63

Martsenyuk V.P., Andrushchak I.Ye., Sverstiuk A.S., Klos-Witkowska A., Bernas M., Witos K. Systems analysis of intelligent Big Data good practice within the framework of medical and biological processes 64

Mashchenko S.O. On sums of fuzzy numbers with fuzzy sets of operands 65

Mumladze I. Modern construction solution of friction diaphragm in the monolithic reinforced concrete buildings 66

Mykhailiuk I.S., Prytula M.M. Bi-Hamiltonian structure and exact solutions of one Burgers' type nonlinear dynamical system 68

Nakonechnyi O. H., Kudin H. I., Zinko P.M., Zinko T. P. Guaranteed estimates of matrixes in linear regression problems with small parameter 69

Nakonechnyi O.G., Shevchuk I. M. Decision support system model for analysis of information spreading processes 71

Nanobashvili K. Problem analysis of management and decision making in business under remote management 72

Natroshvili L. Problems of making resolutions in the process of professional training of students in terms of the pandemics 74

Niftullayeva Sh. Boundary value problem for the composite type equation with nonlocal boundary conditions on a plane semi-band 76

Nikitin A.V., Kravets O.V., Nikitina T.R. Simulation and analysis of movement flow of vehicles using random evolutions under the Poisson approximation scheme 77

Panchenko T., Tyshchenko B., Yavorskii A. ECG analysis with high precision and recall 78

Pankratova N.D., Pankratov V.A. Strategy for planning underground infrastructure of large cities in conditions of uncertainty and multifactor risks 79

Pashko A. Statistical simulation in traffic analysis problems..... 80

Pasichnyk O. Solvability of the fractional Cauchy problem in the space of distribution 81

Perehuda O.V. On the behavior of solutions of a system of two conjugate damping oscillators 82

Petlenko Yu.V., Kapustian O.A., Kharlamova G.V. Simulation of financial stabilization for ukrainian classical universities in the condition of the global pandemic COVID – 19 83

Petlenko Yu., Pohribna N. Tough financial decision making of universities under the current challenges 84

Ponomarov V., Lebedev E. On the problem of explicit representation of state-dependent retrial queues steady state probabilities 85

Prysyazhnyk K., Bazylevych I., Aliyev S. A Conditional limit theorem for a critical branching process with the migration 86

Prishlyak A.O., Loseva M.V. Topology of structurally optimal Morse flows on 3-dimensional handlebody 87

Romanenko V., Miliavskyi Y., Kantsedal G. Dynamic decision-making for cryptocurrency rate stabilization based on the impulse process model in the cognitive map 88

Rozora I.V., Lukovych O.V. Simulation of FBM as input signal on the linear system 89

Ryzhov A. Predicting temporal dependency between mortality and incidence rates using dynamic time-lag regression model..... 90

Semenov V., Siryk D., Kharkov O. About convergence of the operator extrapolation method 91

Semenova N., Manovytska D., Dolenko G. Decision making problem related to charging station for electric transport..... 92

Senio P.S. Functional interval of the solution of a general boundary value problem..... 93

Shakhno S.M., Yarmola H.P. Newton-secant type method with approximation of the inverse operator 94

Sharapov M. Complication of SQL-injections results analysis. Probabilistic approach 95

Shatashvili A.D., Fomina T.A., Didmanidze I.Sh., Papazova E.N. On one method efficient construction of the Hilbert-Schmidt operator providing the equivalence of two Gaussian measures in the Hilbert space 96

Shatyrko A., Khusainov D.Ya., Buranov Zh. Stabilization in the systems with aftereffect 97

Shcherbatyy M. Mathematical modeling of COVID-19 epidemic and data analysis 98

Shchestyuk N.Y., Tyshchenko S.V. Application of subdiffusion processes to option pricing..... 99

Shevchuk I. M., Vergunova I.V. Analysis of the SIRM-model with birth and mortality rates 99

Shusharin Yu.V., Makarenko A.I., Degtiar S.V. Finite-valued random processes with continuous time 100

Sirenko A.S. Study of stability of systems with delay with switching..... 102

Slabospitsky A.S. Non-stationary parameter estimation by the least squares method with variable forgetting factor and least deviations from ‘attraction’ points for non-linear dynamic systems under uncertainties 103

Sosnenko K.P., Samolyuk T.A. Modeling of processes of intellectual collection, recognition and transmission of information in semi-natural modeling systems 104

Sultanova V. Boundary value problem for an equation with second-order partial discrete derivatives 105

Timachov E. Methods and information technology of development of mobile therapeutic and diagnostic complexes..... 107

Tymashov O. Methods and tools of semi-natural modeling in the process of creating complex objects 108

Tupalo Y. Hardware and software and their architectural and structural organization to create a system of semi-natural modeling 109

Turbal Y., Turbal M., Bomba A., Driwi A. A. On the problem of the polynomial extrapolations convergence 110

Tymofijeva N.K. Some ways to solve uncertainty in the problems of artificial intelligence 111

Vavryk P. To ban or not to ban: fighting a trench war in comment sections 112

Vergunova I. The deep Galerkin method in numerical solution of the problem of dynamic control for pollution distribution..... 113

Voina O. Some stochastic models of optimal control of cyclic processes 115

Vyshinskiy V., Vyshinska O., Kononenko O., Slipets A., Eresko V. Current problem in the development of cybernetics..... 116

Yagub G., Ibrahimov N.S., Zengin M. Optimal control problem with the boundary functional for a nonlinear stationary quasi optics equation with a spesial gradient term 117

Yakovliev Yu. S., Yelisieieva O. V. Features of the design of computer systems on the crystal of plic 118

Yarova O.A., Yeleyko Ya.I. Multidimensional renewal equation in nonlinear normalization 119

Yeleyko Y.I., Holovatyi S.I. Finding theoretical functions of distribution for a large sample..... 120

Zhuk T. Yu., Kasimova N.V. Application of the averaging method to the linear by control optimal control problem for the system of differential inclusions with fast parameters..... 121

Zhukovska N.A., Zhukovskyy V.V., Rajab H. Mathematical modeling of one-dimensional non-stationary stress-strained state of soil massif with free surface under heat and mass transfer 122

Zhukovskyy V.V., Zhukovska N.A.,Kraychuk S.O. Application of multicriterial decision-making method for classification suitable sites for organic agriculture..... 123

TYPES OF MEASUREMENTS OF THE TRAFFIC FLOW CHARACTERISTICS

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Traffic flow is determined by three variables: *intensity, velocity and density*. The relationship between these three values is determined by the basic traffic flow equation:

$$q = k \cdot u ,$$

where q is the flow rate, auto/h; k - flow density, auto/km; u is the flow velocity, km/h. The components of this equationn are determined by one of three basic measurement methods.

Intersection measurements are measurements that are taken perpendicular to the direction of the road and at an intersection with the full-width intersection line.

Section measurements. Such measurements are taken at sections located between two intersections of roads.

System measurements are of two types:

1. In physical or geometric measurements, a road is viewed as a system or something as a whole. The road element under consideration is separated by boundaries, and further input and output characteristics of the system are measured at these boundaries.

2. A certain group of vehicles is also considered as a system. Measurements are made for N vehicles in accordance with the measurements of their forward movement.

The *average intensity of movement* $\bar{q}$ can be determined from following equation:

$$\bar{q} = \frac{N}{T}, \tag{1}$$

where N - is the number of vehicles passing through this intersection, auto; T is the duration of the observation period, h.

The *volume of movement* Q during time T is determined by the following formula:

$$Q = \int_0^T q(t)dt , \tag{2}$$

where t – time; q - movement intensity.

All calculations in the article are performed using computer programs.

The present article deals with all the above mentioned issues.

THE IMPORTANCE OF STUDENT AUTONOMY IN TEACHING FOREIGN LANGUAGES

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Learning is a process that must be realized by the learners themselves. The growing need to be able to organize and control one's own learning as well as to continue learning independently results from the accelerating social change of today in the global context. The competence to apply what has been learned is to be found in work and everyday life. But to know and understand one's own learning begins with knowing in which way one likes to learn. The answer to this, as it seems, simple question of how to learn and how to like to learn is not always so easy to give. It requires that you actively deal with your own competences and preferences. For this, learners usually need hints and suggestions.

The aim of this article is to first learn about different ways of learning in order to know which ones they prefer and which ones are effective for themselves. In order to find out how they like to learn, learners should not only give an answer spontaneously, but first try different learning paths in order to then decide what they like best and, above all, what actually works best.

In a Georgian learning culture, students expect teachers to give them strong guidance and that this is the surest path to success. It is in this context that I teach. Unfortunately, my students have no experience of thinking about their own studying. They don't know where to start. This is especially true if there are no guides, questionnaires, or key questions to think about.

Independent learning usually has to be trained. Learners do not know from the start what they are good at, what they have to practice and what materials they can work well with. For the training they need the help of the teacher. Accordingly, the teacher should create a learning environment in which the learners learn to make their own decisions, learn about learning paths and get the help they need. By the way, independent learning does not mean that learners only learn by themselves or that they decide everything for themselves. Just as they choose materials and learning paths themselves, the teacher should also decide whether they prefer to do certain tasks alone or together with others. Learning activities in class should therefore be designed in such a way that there is something for the learners to discover. It is important

that the learners can make their own decisions, for example by choosing between different content or trying out different learning paths.

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THE IMPACT OF WORLDVIEW THEORY ON THE DECISION-MAKING PROCESS IN BUSINESS EDUCATION

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The present scientific paper outlines that business education plans have been realized, someone, obviously, should execute actually each of the problems following from the purposes of the organization. For this purpose the management is obliged to find an effective way of a combination of the key variables describing worldview problems. Statement of the purposes and maintenance with their policy, strategy, procedures and rules promotes the decision of this theoretical problem. The motivation and the control also play an essential role in maintenance of efficiency of performance of worldview tasks. However the business education organization as process represents function which is the most obvious and directly is connected with regular coordination of many worldview problems and, accordingly, formal mutual relations of academic persons - What place in the theory of management borrows the control? It is connected with expansion and complication of activity of major concerns, concentration and diversification. The administrative control, being a necessary condition of functioning of any economic mechanism, in modern conditions receives the further theoretical development and practical perfection on the basis of improvement of methods of the administrative account and the automated processing of the information, application of analytical methods of decision-making the system analysis.

The paper discusses, that according to work [1] the online cycle of information use in decision-making, “In particular, a typical example of

such traditional encounters was trust board meetings. During these meetings we did observe the online educational process in action, with the chairperson usually setting up the scene and some member of the executive team presenting the background information and the supporting evidence collected prior to the meeting. This would be customarily followed by a discussion when the online participants would ask probing theoretical questions and test the validity of the worldview argument" [1]. In the Georgian authors' opinion, "worldview is developed from a great number of cooperating components that represent an integral system. It is reproduced in the form of a poly-modal mosaic of sounds, colors, tactile and visual sensations in the perception" and "a number of practical applications, one of which is the use of educational technology [2]

The paper concludes that the concept of business firm theory as open social system has been in detail shined, classification of the industrial enterprises is given. Very big attention is given in research to classical functions of management - planning, the organization, motivation and to the control. At discussion of strategic planning process of a choice of the purposes of the organization and ways of their achievement has been considered. The functions of management are considered not only as economic aspect in production management, but also social since education in the industry is not only worldview theory of operational systems, but also the most important - management of people. And as it will pass depends already on a company management, from their experience, knowledge, flexibility [3]. Very big section is devoted to assessment of manpower to social production management which problem consists, in essence, an increase of a social worldview maturity of collective. Satisfaction work of members of collective, a level of development of intra-collective attitudes, a moral and psychological atmosphere of collective, a degree of involving of workers in production management, constant interest in increase of its efficiency, a worldview level of turnover of staff, creative activity of workers - these parameters substantially reflect a level of a social maturity of a work collective [4]. And by means of these parameters the worldview theory estimation of efficiency of social educational activity of the head of a collective business and business organization systems are usually formed.

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DATA INCONSISTANCY AND COVID-19 PANDEMIC PREDICTING

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The COVID-19 pandemic is one of the main global problems of last decades. Effective decision-making on minimization of the pandemic effects requires both an understanding of the mechanisms of its spread and reliable data on its main characteristics, as well as data on other factors which are important for forecasting. The main medical data are cases number, serious cases number, deaths number, CFR, IFR, tests number, vaccination number. The last two indicators are measured relatively accurately. But data can come with a time delay. Data on the number of deaths in many countries are significantly underestimated. For example, according to [1, on April 16], the number of deaths in Ukraine is underestimated by about 2.1 times, in Russia – 5.4, in Kazakhstan – 12, in Egypt – 13, in Tajikistan – 97. More accurate estimates can be obtained from excess mortality. But such data usually become available with a delay of 1-2 months, and in some countries delays are much greater or the data are not available at all. In addition, in some countries, excess mortality is significantly lower than the number of “Covid” deaths indicating that this relationship is not unambiguous and also depends on other factors. The uncertainty of other indicators is much greater. For example cases data in most countries are 3-100 times higher than official one as evidenced by the results of serological tests. For Ukraine, this difference is 3 – 7 times

according to the simulation data and can be significantly higher by other data.

Therefore, it is a need to involve additional information for pandemic predicting. In particular, these are data on the dynamics of population mobility, search queries, computer simulation results, etc. Demographic and economic data should also be used for predicting.

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SOME APPROXIMATE PROPERTIES OF CESARO MEANS FOURIER SERIES AND THEIR CONJUGATES

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Some approximate properties of Cesaro means of negative order of Fourier trigonometric series are established.

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

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

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

where

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

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

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

We imply, that

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

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

$$\omega(\delta, f)_p = \sup_{|h| \le \delta} \| f(\cdot + h) - f(\cdot) \|_p,$$

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

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

where

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

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

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

Theorem 1. Let $\alpha \in]0,1[$ and $p \ge 1$. If $\alpha p = 1$ and $f \in Lip(\alpha, p)$, then

$$\left\| \sigma_n^{-\alpha}(x, f) \right\|_p = A(p, \alpha), \quad n = 1, 2, ...$$

Theorem 2. Let $\alpha \in]0,1[$ and $p > 1$. If $\alpha p = 1$ and $f \in Lip(\alpha, p)$, then

$$\left\| t_n^{-\alpha}(x, f) \right\|_p = A(p, \alpha).$$

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THE IDEA OF CONSTRUCTING A GENERAL METHOD FOR MINIMIZATION FUNCTION OF MANY VARIABLES WITH OVER THE QUADRATIC ORDER OF CONVERGENCE

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Consider the problem

$$f(x) \to \min \quad \text{для } x \in R^n \tag{1}$$

To solve a task (1) there are a number of methods.We offer some new idea for construct methods for solving problem (1)

$$u_k = \Phi(x_k)$$
$$x_{k+1} = x_k - f'(x_k, u_k)^{-1} f'(x_k), \quad k = 0,1,....$$

where $\left\|\Phi(x) - x^*\right\| \le K \left\|x - x^*\right\|^{\tau}$, $\tau \in [1,2]$, $0 < K < \infty$.

We have formulated and proved the theorem on the rate of convergence of the general method which is described as follows

$$\left\|x_k - x^*\right\| \le q^{(\tau+1)^k - 1} \left\|x_0 - x^*\right\|$$

And we also considered specific options for choosing an operator $\Phi(x_k)$, namely these

$$\Phi(x_k) = x_k - \alpha_k f'(x_k)$$
$$\Phi(x_k) = x_k - f'(x_k, x_k + \alpha f'(x_k))^{-1} f'(x_k)$$

For these cases, the theorem on their rate of convergence is also formulated and proved.

TO CONSTRUCTION OF GENERALIZED SOLUTIONS OF CONTROL SYSTEMS

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We are considering problems of minimization of functionals

$$B(x,u)=\iint\limits_{D}\varphi_0(t,s,x(t,s),u(t,s),F^0(x,u,t,s))dsdt,$$

which are defined on solutions of controlled subsystems

$$\overline{f}_i^k(t,s,x,u):=f_i^k(t,s,x(t,s),u(t,s),F^{f_i^k}(x,u,t,s))=0,\ (t,s)\in D(x,u),$$

described by compositions $F^{f_i^k}$ and F^0 of operators

$$F_1(x,t,s,\alpha,\beta):=\frac{\partial^{\alpha+\beta}}{\partial t^{\alpha}\partial s^{\beta}}x(t,s),$$

$$F_2(F_1,x,t,s,\overline{\Omega}):=(F_1(x,t+t^1(x,t),s+s^1(x,t),\alpha^1,\beta^1),\ \ldots,$$

$$F_1(x,t+t^{n_\Omega}(x,t),s+s^{n_\Omega}(x,t),\alpha^{n_\Omega},\beta^{n_\Omega}))\,,$$

that are defined by sets $\overline{\Omega}(t,s)=\{t^i(t,s),s^i(t,s),\alpha^i,\beta^i\}_{i=1}^{n_\Omega}$ and $\tilde{\Omega}(t,s,x,u)\subset R\times R^{n_s}$.

A generalized optimal solution is defined as a sequence

$$(x_k,u_k)\in\Omega(\varepsilon_k),\ \ B(x_k,u_k)\le\inf_{(x,u)\in\Omega(\varepsilon_k)}B(x,u)+\varepsilon_k,\ \varepsilon_k>0,\ \lim_{k\to\infty}\varepsilon_k=\overline{\varepsilon},$$

where $\overline{\varepsilon}$ is the minimum value for which the set $\Omega(\varepsilon)$ of solutions of system

$$|\overline{f}_i^k(t,s,x,u)|\le\varepsilon,\ \ (t,s)\in D^i(x,u)\,,\ k=\overline{1,N_k}\,,\ i=\overline{1,N_{ki}}$$

is nonempty for $\varepsilon>\overline{\varepsilon}$. The construction of generalized solutions is realized using approximations of controlled subsystems in adequately parameterized classes of phase trajectories and controls.

COMBINED GLOBAL MINIMIZATION ALGORITHMS

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Global minimization algorithms are important tools to support decision-making in conditions of geometric incompleteness of the data $y \in Y$ about parameters y of the optimality criterion $f(x, y)$ to be minimized on an admissible set $x \in X$ by solving optimization problems

$$x = \arg\min_{x \in X} \varphi(x),\ \varphi(x) = \max_{y \in Y} f(x, y),$$

and for complex systems controls optimization by global optimization of Hamiltonians. The combined global optimization algorithms are constructed by implementing of classical search procedures of nonlinear programming with stochastic procedures of Monte Carlo methods (at the localization stage) and with optimal search procedures for the global minimization for Lipschitz functions $\varphi(x)$. For functions with Lipschitz constant L we have

$$\varphi(x_k) - L\|x - x_k\| \le \varphi(x) \le L\|x - x_k\| + \varphi(x_k)$$

and thus we calculate the minimal value

$$F_k = \min\left[\varphi(x_1), \varphi(x_2), ..., \varphi(x_k)\right]$$

for which the inequality $\min_{x \in X} \varphi(x) \ge F_k - \varepsilon$ holds (when performing one of the inequalities

$$F_k - \varepsilon \le \varphi(x_i) - L\|x - x_i\|).$$

The value of F_k is an approximate (with accuracy ε) of the global minimum of the function $\varphi(x)$ on the set

$$\Delta_k = \bigcup_{i=1}^{k} \{X \mid \|x - x_i\| \le \left(F_k - \varphi(x_i) - \varepsilon\right) / L = R_i\}.$$

Experimental calculations confirm the practical efficiency of combined algorithms.

AN APPROACH FOR THE SCENE CHANGE LOCALISATION

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The scene change detection is an important task [1]. This task can help to analyze video-stream automatically: which characters appear in which scenes, how many of them interact and for how long, their relations and importance, and also to track many more issues. The potential solution can rely on different facts: objects appeared, contrast or intensity changed, other colorization appeared, background changed, even sound changed. There are of course a lot of uncertainties in this kind of analysis, for example: when the scene was exactly broken?

As usual, analysis relies on the frame-by-frame basis [2], but there are also many other signals to take into account. Also, many such systems have a “false positives” [3], which means the localization of scene cut where it has not really changed – just some phantom artefact appeared. Different methods use RGB, HSV and other color information.

The proposed method tries to decrease influence of these problems and takes into account fade-in and fade-out effects, adaptive threshold instead of static one for dynamic analysis, and dynamic windowing for more precise scene clustering.

This method appeared to be effective, slow. It could also be upgraded by adding the sound analysis and more precise localization of phantom objects, which could appear in video stream, distilling them from the total scene change situation.

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MODELING DEVELOPMENT OF INFECTIOUS DISEASE IN CONDITIONS OF CONCENTRATED INFLUENCES TAKING INTO ACCOUNT DIFFUSION PERTURBATIONS AND CONVECTION

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This paper dials with the modified mathematical model of infectious disease of G.I. Marchuk for taking into account diffusion *disturbance* and convection in conditions of point-concentrated corrective-therapeutic effects. We reduced the solution of the corresponding singularly disturbed problem with time-delay to a sequence of solutions of problems without time-delay and presented them in the asymptotic series form as perturbation of the solutions to the corresponding degenerate problems. *We* illustrated that diffusion "redistribution" over a certain period provides a reduction in the critical values of the antigen concentration in the locus of infection, and then their further neutralization according to the available level of immune defence will require fewer donor antibodies.

The developed computational procedures can be used in the building of specialized decision support systems: in this particular case according to the input intensity of diffusion "redistribution", distribution of antigen sources, so we can rely on the immune defence of the organism or we have to carry out external corrective-therapeutic effects, in particular, to introduce donor antibodies. Moreover, in the last case it means to establish their most acceptable concentration in each injection, the most comfort time, frequency, and place and injection technique.

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FINITE M/M/1 RETRIAL MODELS WITH CHANGEABLE SERVICE RATE

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This article deals with the retrial queue, where customers arrive following a Poisson process with rate λ. The retrial time distribution is exponential with parameter ν. The service time distribution function is exponential for both primary and repeated calls. If at the instant when a customer (primary or repeated) gets the service, the system has j, $j \geq 1$ customers (j = the number of customers in the orbit +1), then the parameter of the service time is equal to μ_j.

Let $\xi(t)$ stand for the number of customers in the orbit at time t, and $\eta(t)$ define the state of the server at that time: if the server is free, then $\eta(t) = 0$, and $\eta(t) = 1$ otherwise. Two component process $(\eta(t), \xi(t))$ is a homogeneous markov process with phase space $S = \{(i; j); i = 0; 1; j = 0; 1; 2; \ldots\}$.

In the case where service intensity depends on the number of customers in the system the process $(\eta(t), \xi(t))$, in contrast to [1],[2], is not markovian, but we can make it markovian prescribing another sense to the component $\eta(t)$.

In this article we deal with a system with finite orbit $m < \infty$. The markov process $(\eta(t), \xi(t))$ corresponding to such a system is always ergodic and its state space has the form $E = \{(i, j), 0 \leq j \leq m, 0 \leq i \leq j+1\}$.

The effective approach to find a steady state distribution of the service process is proposed. The only explicit formulae for the state stationary distribution have been derived for the finite M/M/1 retrial models with changeable service rate.

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THE COMPENSATING OPERATOR OF THE DIFFUSION TRANSFER PROCESS IN THE CONTROL TASK

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Consider the control task for the diffusion transfer process in the scheme series with small parameter $\varepsilon > 0$ in the form [1]:

$$dy^{\varepsilon}(t) = a(y^{\varepsilon}(t), x(t/\varepsilon))dt + \sigma(y^{\varepsilon}(t), x(t/\varepsilon), u^{\varepsilon}(t))dw(t), \qquad (1)$$

and the stochastic optimization procedure for the control $u^{\varepsilon}(t)$ in the form: $du^{\varepsilon}(t) = \alpha(t)\nabla_{\beta(t)}G(y^{\varepsilon}(t), x(t/\varepsilon), u^{\varepsilon}(t))dt, \qquad (2)$

where $y^{\varepsilon}(t)$ - the transfer process, $x(t)$ - semi-markov switching process

$$\nabla_{\beta(t)}G(y^{\varepsilon}(t), x(t/\varepsilon), u^{\varepsilon}(t)) = (G(y,x,u+\beta(t)) - G(y,x,u-\beta(t)))/\beta(t)$$

Theorem. The copmensating operator $L_t^{\varepsilon}(x)$ [2] in the control task (1),(2) has representation:

$$L_t^{\varepsilon}(x)\varphi(y,x,u) = \varepsilon^{-1}Q\varphi(y,x,u) + \varepsilon^{-1}q(x)\int_0^{\infty} G_x(ds)[D_{t+\varepsilon s}^{t,y}(x) - I]P\varphi(x,y) +$$

$$+\varepsilon^{-1}q(x)\int_0^{\infty} G_x(ds)[D_{t+\varepsilon s}^{t,u}(x) - I]P\varphi(x,u),$$

where Q- the generator of semi-markov process $x(t)$[2], $G_x(t)$- the function of distribution of the staying time of the process $x(t)$ at state X [2], $P\varphi(x) = \int_X P(x,dy)\varphi(y)$; $D_{t+s}^{t,y}(x), D_{t+s}^{t,u}(x)$- semigroups with such set generators $D_{y,t}(x), D_{u,t}(x)$: $D_y(x)\varphi(y) = \alpha(y,x)\varphi'(y) + 1/2\,\sigma^2(y,x,u)\varphi''(y)$, $\varphi(y) \in C^2(R)$, $D_{u,t}(x)\varphi(u) = \alpha(t)\nabla_{\beta(t)}G(y,x,u)\varphi'(u)$, $\varphi(u) \in C'(R)$.

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FORMALIZED REPRESENTATION OF STUDENT MOBILITY DECISION-MAKING

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The recommended decision-making process for student mobility is based on rational theory and discussion that explores the complexity of decision-making, its rational and less rational aspects. It should be noted that the main stages of decision making for any subject area, whether it is student mobility or complex objectmanagement,does not different from each other in content and it can be presented as the sequential chain of relevant stages of the object.

It is very important how we evaluate the effectiveness of the mobility decision in advance before we result its consequences. The biggest difficulty for student's self-assessment of decision effectiveness is that a student will not be able to adequately evaluate the effectiveness of the decisionuntil a decision causes the negative consequences.

In the presence of fact, it is easy to determine whether a better decision could have been made. There are sometimes the cases in practice, when a student changes the place of mobility, it causes both moral and financial as well as other losses. To prevent the mentioned, the decision must be evaluated by clarifying all the available information of the alternative university, analyzing and comparing the data with logical reasoning and drawing appropriate conclusions confirming the effectiveness of the decision.

The possible consequences of mobility can be formulated as follows:

Make the following notes:

Set of Alternative Universities:

$$A_u, \quad u = \overline{1,n};$$

Set of probable results of choice:

$$S_s, \quad s = \overline{1,m};$$

The results obtained based on the selection of alternatives can be formally presented as follows:

$$(A_1 \to S_1) \wedge \overline{S_m \setminus S_1} \vee (A_2 \to S_2) \wedge \overline{S_m \setminus S_2} \vee \ldots \vee (A_n \to S_n) \wedge \overline{S_m \setminus S_n}.$$

It can be logically argued that if a student makes the decision to choose

an A_n alternative, then there will be a S_n result that precludes other $S_m \setminus S_n$ results.

A SYSTEMATIC APPROACH TO STUDENT MOBILITY DECISION-MAKING

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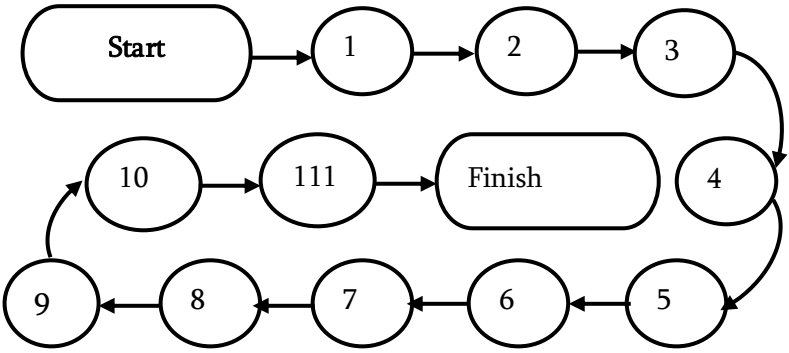
According to bologna declaration– student mobility transportation is not university administration issue – student makes this decision him/herself. University only have monitoring function, so that decision making stays democratic, which approves mobility for all without conflict, assists students in making academic results documents. Problems, which arise in university during practical realization of mobility, mainly are connected to difficulty to get detailed information from universities inside and outside country. Student is obliged to act according to certain conceptions and rules in achieving mobility. This conceptions and rules are deviated from education laws and regulations, which university uses in its own regulations.We can say that this process is not formal and needs system.



Scheme. 1.Consistent stages for mobility

On scheme 1 you can see that we offer to link all stages in dependent linear chain.

The contents of the digital notation given in Figure 1 are as follows:

1. Necessity of mobility;
2. Existence of situation;
3. Readiness for mobility,
4. Possibilities;
5. Set of alternative universities;
6. Set of alternative faculties in the universities under consideration;
7. Set of alternative specialties in the faculties;
8. Choosing between alternatives;
9. Decision making;
10. Assessment of decision,
11. Realization of decision.

In Presentation we are going to talk about all stages of chain, their purpose and meaning.

AN APPROACH TO POSTOPTIMALITY ANALYSIS OF MULTIOBJECTIVE LINEAR OPTIMIZATION PROBLEM WITH BINARY VARIABLES

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An important problem in the energy sector is to select an optimal set of measures that will be the most beneficial for energy system modernization in a particular region considering identified criteria and existing constraints. The following multiobjective zero-one linear mathematical model can be used to describe this problem:

$$\sum_{j=1}^{n} c_{ij} x_j \to \max, i \in Q = \{1,...,q\},$$

subject to $\sum_{j=1}^{n} a_{lj} x_j \le b_l$,$l \in M = \{1,...,m\}$, $j \in N = \{1,...,n\}$,

$$\text{where } x_j = \{0,1\},\ j \in N.$$

The decision maker has to specify multiple parameters that may have uncertain values or may require reconsideration. Therefore, an approach to facilitate postoptimality analysis is discussed here.

On the first phase of suggested procedure the problem is solved by modified Balas implicit enumeration algorithm, obtained partial solutions are verified, and additional information about partial solution and its corresponding constrains is stored for future reference. Then

during the second phase, the stability of previously obtained optimal solution is investigated with respect to changes of right sides of constraints and coefficients of criteria functions [1-3].

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METHOD AND ALGORITHM FOR CONVERTING EXPRESSIONS FROM DISCRETIZED SINGULAR INTEGRALS

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For a class of problems with unknown and moving boundaries [1,2], there are models that have an analytical representation in the form of special integrals along the boundary, with parametric time dependence.

$$\Phi(z,t)=\phi(x,y,t)+i\psi(x,y,t)=\frac{1}{2\pi i}\int\limits_{L_d(t)}\gamma(\omega,t)\ln(z-\omega)d\omega+ \\ +\sum_{p=1}^{P}\frac{1}{2\pi i}\int\limits_{L_v^p(t)}\gamma(\omega,t)\ln(z-\omega)d\omega, \tag{1}$$

$$\bar{V}(z,t)=u(x.y,t)-iv(x,y,t)=\frac{\partial\Phi(z,t)}{\partial z}= \\ =\frac{1}{2\pi i}\int\limits_{L_d(t)}\frac{\gamma(\omega,t)}{z-\omega}d\omega+\sum_{p=1}^{P}\frac{1}{2\pi i}\int\limits_{L_v^p(t)}\frac{\gamma(\omega,t)}{z-\omega}d\omega, \tag{2}$$

Discretized models, using singular integrals:

$$\Phi(z,t) = \phi(x,y,t) + i\psi(x,y,t) =$$

$$= \sum_{j=1}^{M} \frac{\Gamma_j(t)}{2\pi i} \ln(z - \omega_{0j}(t)) + \sum_{p}^{P} \sum_{s=1}^{n(t)} \frac{\delta_s^p}{2\pi i} \ln(z - \omega_{0s}^p(t)), \tag{3}$$

$$\bar{V}(z,t) = u(x.y,t) - iv(x,y,t) =$$

$$= \frac{\partial \Phi(z,t)}{\partial z} = \sum_{j=1}^{M} \frac{\Gamma_o(t)}{2\pi i (z - \omega_{0j})} + \sum_{p}^{P} \sum_{s=1}^{n(t)} \frac{\delta_s^p}{2\pi i (z - \omega_s^p(t))}. \tag{4}$$

The deformation of the flow region $D(t)$ is determined by the movement and deformation of different types of boundaries $L_d(t)$, $L_v(t)$ and $L_s(t)$, as well as the generation of new elements of these boundaries. To calculate the dynamic characteristics of the process in the field of determining the sampled characteristic function, there is an expression for the time derivative:

$$\frac{\partial \phi(x,y,t\ )}{\partial t} = \sum_{j=1}^{M} \frac{\dot{\Gamma}_j(t)}{2\pi} arctg\left(\frac{y - y_j(t)}{x - x_j(t\ )} \right) +$$

$$+ \sum_{p=1}^{P} \sum_{i=1}^{n} \frac{\dot{\delta}_i^p(t)}{2\pi} arctg\left(\frac{y - y_i^p(t)}{x - x_i^p(t)} \right) + \sum_{p=1}^{P} \frac{\dot{\delta}_{n+1}^p}{2\pi} arctg\left(\frac{y - y_{n+1}^p(t)}{x - x_{n+1}^p(t)} \right) -$$

$$- \sum_{j=1}^{M} \Gamma_j(t) \left(\vec{V}_j(x,y,x_{0j}(t_{n+1}), y_{0j}(t)), \vec{W}_d(x_{0j}(t), y_{0j}(t)) \right) - \tag{5}$$

$$- \sum_{p=1}^{P} \sum_{i=1}^{n+1} \delta_i^p(t) \left(\vec{V}_i(x\ , y\ , x_i^p(t), y_i^p(t)), \vec{W}_v(x_i^p(t), y_i^p(t)) \right)$$

To correctly calculate the time derivative of an expression with discontinuous functions (3), the method and algorithm of transformation of the discretized singular integrals are developed. The method and algorithm for calculating the dynamic characteristics of the process in the region, almost to the limit, are presented.

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PRINCIPLE OF TIME STRETCHING IN GAME DYNAMIC PROBLEMS

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The deciding factor in study of dynamic games is availability of information on current state of the process, its prehistory or various-kind discrimination of the players. In the course of conflict-controlled process the player making decision, as a rule, obtains delayed information about current state of the game or choice of control by its adversary. It is shown that the dynamic quasi-linear game of pursuit with time-variable delay of information is equivalent to the pursuit game with complete information and somewhat changed dynamics and terminal set [1].

On the one hand, this makes it possible to apply classic methods for analysis the game with delayed information. On the other hand, this turns out to be useful to tackle game problems of pursuit, for which Pontryagin's condition does not hold. These are the problems of soft meeting (simultaneous coincidence of states and velocities of the players) and problems of pursuit for oscillatory processes. This condition reflects an instantaneous advantage of the pursuer over the evader in control resources expressed through the game parameters. D. Zonnevend [1] suggested medication of this condition that incorporates certain function, later on called the function of time stretching. Establishment of close relation of the modified condition with the passage from original game with complete information to the game with special kind information delay gave impetus to the development of efficient approach, the principle of time stretching [2]. Concept of function of time stretching was extended from continuous function to a sum of piecewise continuous and absolutely continuous functions. It made it feasible to expand the range of problems, susceptible to analytic solution, in particular, at the account of the oscillatory systems. All studies were carried out both on the basis of Pontryagin's First Direct Method and Method of Resolving Functions. A number of problems of soft meeting of oscillatory systems were first solved in analytic form.

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PRINCIPLES OF A SYSTEMS APPROACH IN MODELING

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The main provisions of the theory of systems arose in the course of the study of systems and their functional elements. To start building a system, you need a general description of technological processes. The same can be said about the principles of creating mathematically formulated criteria that a theoretical description or process must comply with. Modeling is one of the most important methods of scientific research and experimentation.

When creating object models, a systematic approach is used; this is a methodology for solving complex problems based on an object as a system, functioning in a certain environment. The systematic approach involves disclosing the integrity of an object, identifying and studying its internal structure, as well as its connections with the external environment. In addition, an object is a part of the real world that is isolated and studied when building a model to solve a given problem. In addition, the systems approach assumes a gradual transition from general actions to specific ones, when the purpose of the review is to build a model of the system, and the object is considered in relation to the environment.

Along with the system, there is usually a supersystem - a system of a higher level, which includes the object under discussion, and the function of any system can be considered only through its subsystem. We must distinguish the concept of the environment as a set of objects from the external world, which have a significant impact on the efficiency of the system, but are not part of the system and its subsystem. Regardless of the type of model, when building it, it is necessary to be guided by the principles of a systematic approach:

1) consistent progress according to the stages of modeling;

2) coordination of information, resources, reliability and other characteristics;

3) the correct ratio of the various stages of model building;

4) combining the individual stages of model building.

These issues are highlighted in this article.

PREREQUISITES FOR THE TASK OF FORECASTING THE DEMAND FOR SPECIALISTS IN THE REGION

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The formation of the concept of training specialists with technical education for the region is significantly influenced by the state of enterprises and other economic facilities in the region, the addition of new facilities provided for in the strategic plan, and the reconstruction of the existing ones; the requirements for technical personnel, for their professional level, knowledge of modern management technologies.

One of the main goals of regional management should be training young specialists and creating a competitive environment for them in the labor market. This will enable young people to make the most of their intellectual abilities.

Higher educational institutions of the region should play a special role. Based on the requirements of the time, they are obliged to carry out reforms, to improve curricula, to create objects for undergoing student internships, to provide strong laboratory facilities, similar simulators of processes in a particular area and adequate virtual systems.

Universities have the opportunity to participate in various educational exchange programs, which are implemented both at the initiative of the Assembly of European Regions and by other structures. This allows young professionals to undergo training / internships, gain professional experience and contribute to self-affirmation in the international labor market.

The disbalance in the personnel policy of the region, in addition to various subjective and objective reasons, is created by the fact that the concept of regulating this process has not been developed at the scientific level yet.

The present article deals with all the above issues.

CARGO SHIPPING PLANNING AND INTEGRATED INFORMATION TECHNOLOGY SYSTEM

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In order to reduce time and financial costs in the process of cargo transportation, the integrated action of all measures related to this process and the latest technological means are intensively applied nowadays.

Such kind of integration process, where the main priority is the use of information systems and technologies, has been known as "logistics".

During the process of cargo transportation/movement, a significant part of transport logistics operations from its initial location to the customer is carried out by various means of transport: water transport (sea, river), road, rail, air and pipeline transport.

The following tasks of transport logistics are defined initially:

- Choose the sort of transport;
- Choose the type of transport;
- Plan warehousing operation;
- Joint planning of the transport process for different types of transport (in case of mixed shipments);
- Provision of technological unit of transport-warehousing process;
- Determine the rational route of delivery;
- Plan of cargo loading-unloading operation on transport;
- Calculation of the optimal option for placing (loading) cargo on transport.

The cost of services provided by transport organizations is important in logistics, which is determined by the established shipping tariffs, which include: freight rates; the amount of additional transactions and salary reimbursement related to the shipment of cargo.

Logistics operation is a continuation of the technological process. For example, packaging - this operation pays attention to the consumer characteristics of the goods. It can be implemented both in the production and in the opposite field, for example, in the wholesale base.

These issues are the focusedin this paper.

EDUCATION AND COMPUTER TECHNOLOGY

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Today we can say that the use of computer technology provides tremendous opportunities for the development of the educational process. Today there are a sufficient number of educational computer programs that are successfully used to obtain and control knowledge. Such systems operate in test mode, where it is possible to answer based on the choice of an answer, depending on whether the answer is correct or not. The system has an additional feature that allows you to re-select an answer. Such tests have to take into account the number of correct and incorrect answers received. Such a test can be used to determine the level of training of the student and his/her desire to study a specific part of the curriculum.

Modern educational requirements with their existing problems and prospects for future development make us think about how to achieve ever greater improvement and greater efficiency in the learning process. How and in what ways to carry out the educational process so that the student has a desire and aspiration for knowledge.

The field of application of interactive technologies in the educational system is growing rapidly every day and is constantly being improved. This is a thorough process, since the benefits of interactive models are obvious, they stimulate active communication between students and teachers and teamwork, they are easy to use, they are fun and exciting to work with.

Nowadays, we need the ability to get information from different sources, use it and create it independently. The practical use of information and communication technologies gives the teacher new learning opportunities, greatly facilitates his work, increases the effectiveness of teaching, and improves the quality of teaching.

These issues are highlighted in this article.

RELIABLE FEM SCHEMES FOR ELASTICITY PROBLEM BASED ON FEM-BEM ERROR ESTIMATORS

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The adaptive versions of FEM [1] are the basis for building reliable FEM schemes [2]. We present two an error estimators, based on the difference in stress values received by finite element method and boundary element methods: FEM and DBEM (direct boundary element method) and FEM and IBEM (indirect boundary element method) [3]. It is well-known that the stresses, obtained on the base of these methods have different orders of convergence. Using this difference, we constructed an elementwise stress error estimator for the mesh adaptation. Nonconforming grids, which arise in adaptation process, are overridden through the weak-continuity condition and mortar functions. Numerical examples that illustrate the validity of the estimators in both issues on conforming and nonconforming grids was investigated

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SEQUENTIAL RESOURCE ALLOCATION UNDER MULTI-ARMED BANDIT MODEL WITH DELAYS

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We consider policies for the sequential resource allocation problem under the multi-armed bandit model in the stochastic environment with delays. We study the environment where the resources are associated with Bernoulli distributions. The effectiveness of one of the policies (Explore-First) is examined and various numerical experiments are provided to support the findings.

The underlying stochastic multi-armed bandit problem was first described by Robbins in 1952 [1] and the notion of regret as the measure of effectiveness in [2]. The problem represents the exploration-exploitation trade-off in the scope of the sequential design of experiments. We provide the regret (asymptotic) analysis for the policy Explore-First and study the effect of the delays.

Most existing policies retain theoretical guarantees only in the environments with no delays, when results are available immediately. One possible solution to mitigate the issue with delays is to encapsulate the policy into the meta-algorithm designed by Joulani et al. [3]. We incorporate their work and obtain the upper bound for the stochastic environment under delays. The effectiveness of the algorithm decreases in an additive term with respect to the delays.

The obtained results have been used to develop software for conducting numerical experiments of the stochastic multi-armed bandit model with delays [4].

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ABOUT THE VIRTUALIZATION OF COMPONENTS OF MODERN COMPUTER SYSTEMS FOR SCIENTIFIC RESEARCHES AND SEMI-NATURAL MODELING

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The current level of development of computer technology provides new opportunities for building various computer systems and for information support for solving user problems in the field of automation of scientific research, in the construction, semi-natural modeling and

study of elements of complex objects, in the automation and monitoring of various technological processes in industry, management, education and everyday life. In this case, certain difficulties arise for developers and restrictions are imposed, which are associated with the need to ensure joint uninterrupted operation in real time of a large number of heterogeneous stationary, mobile, personal computing equipment and various equipment for collecting, processing, storing, transferring and presenting data to the end user. or a computer system.

The use of complex methods of virtualization of the elements of the developed computer systems can provide, during operation, flexible construction of several virtual information systems on the same specific set of available control objects. At the same time, various users are provided with the necessary information, depending on their access rights and tasks to be solved. The choice of the best options and the duplication of communication channels will ensure real-time operation and the appropriate level of necessary security.

This approach makes it possible to flexibly create virtual information subsystems, virtual desktops or temporary workspaces for new or temporary tasks. At the same time, the possibility of convenient visualization of the required technological process is provided by standard software tools available to the user.

DECISION-MAKING UNDER CONDITIONS OF UNCERTAINTY WITH A FUZZY SET OF ENVIRONMENT STATES ACCORDING TO WALD'S CRITERION

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In this paper, we focus on the finding effective methods of decision-making under conditions of uncertainty with a fuzzy set of environment states [1],[2], [5]. Based on [5] we formulate the problem statement. The basis of the fuzzy maxmin criterion decision-making under conditions of uncertainty with a fuzzy set of environment states that we are considering is the well-known Wald criterion. We use some known facts about type 2 fuzzy sets and intersections of a fuzzy set with a crisp set of operands for constructing a set of feasible alternatives (α_1, α_2)-double [3] cuts plays important role here. Using Zadeh's Extension Principle [4] and intersection and union of type-2 fuzzy sets [3] we define a Type-

2 Fuzzy Set of solutions [5]. Each element of this set consists of a solution, its degree of member function and degree of truth of infeasibility. Degree of truth of feasibility for each alternative is 1. We also use to build an algorithm for finding a solution with a given value degree of truth of infeasibility.

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ABOUT FRACTIONAL ANALYSIS FOR HYBRID MODELING OF INFORMATION DISTRIBUTION PROCESSES

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The tasks of the analytical processing of modern information flows and their influence require solving the problems of studying the dynamics of information dissemination processes based on simulation and forecasting tools. The development of models and methods for simulating information impacts, taking into account the processes of information dynamics, can effectively solve important communication problems, significantly increase the level of information security of the state, and tactically and strategically predict the development of information confrontation events. A constructive method for analyzing the dynamics of information dissemination processes can be proposed based on the use of a fundamentally new toolkit using the method of analogy and hybrid models, which allows adequately reflecting the state of the dynamic component of the process of disseminating [1, 2].

The paper considers the problem of modeling changes of the level of information concentration based on the diffusion equation, assuming

that this process is similar to the spread of a substance over a certain period of time $t \in [0,T]$ and can be described by a scalar equation with a fractional Caputo-Gerasimov derivative of the order α, $0 < \alpha < 1$,

$$D_{0t}^{\alpha} u(x,t) = -k(t) \partial^2 u(x.t) / \partial x^2 .$$

The proposed technique allows us to describe the levels of propagation, influence and storage of information in a local group on the basis of the solution of the diffusion equation, the propagation intervals in which is determined by the additional relationships obtained from the solutions of the additional differential equation.

The practical significance of obtained results is that the proposed methodology form the basis for the development of the applied research project for the analysis of the distribution processes and the influence of information flows in social networks.

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INFORMATION SUPPORT STRUCTURE FOR MOBILITY DECISION-MAKING

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Information support for student academic mobility decision-making should be organized on the basis of databases that include the comprehensive information on the main universities, deans, specialties, curricula, scientific and academic personnel, and student's academic performance. Considering the territorial distribution of databases, the aspect of information support as automated search,is particularly important. The most convenient way of automated search for our case is to integrate the data into a hierarchical structure. Data integration at the semantic level is implemented by merging local databases, one fragment of which is given in the form of an ontology thesaurus - Fig. 1.

At first, an initial ontology should be built, on the basis of which the general ontology will be created for them. The unified information space created in this way allows for the efficient integration of information from different databases and information search.

The data from information sources is linked to the web ontology language - OWL. This information may be student'senrollment data from National Examination Center; data from the student's study period; information about further learning activities, etc. From information tables that are not structured, information search, sorting, and integration into a single spatial ontology is performed with the use of SWRL rules.

The presentation of data and the formation of documents at the semantic level of integration takes place in the context of a unified ontology, considering the semantic features. The integration of information into a single information space is ensured by the integration of individual ontologies into a global ontology. The information search is provided by a system of logical inferences, through which data is retrieved quickly and on demand.

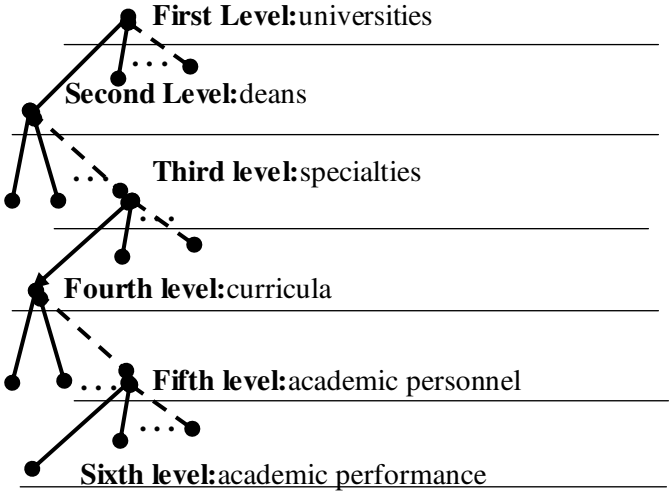

Fig. 1. A fragment of an Ontology Thesaurus

GUARANTEED ESTIMATION OF RIGHT-HAND SIDES OF FIRST ORDER LINEAR PERIODIC ODES FROM INDIRECT OBSERVATIONS WITH DETERMINISTIC AND NOISY ERRORS

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In this paper, we consider the problem of guaranteed estimation of unknown right-hand sides of first-order linear periodic systems of ordinary differential equations which are assumed to be subjected to some quadratic restrictions. In order to determine optimal, in certain sense, solutions of such equations, the additional data (observations) are needed. Here we use indirect observations that are linear transformations of their unknown solutions on a finite system of points and subintervals belonging to the interval of periodicity with additive deterministic or noisy errors. Such a kind of observations is motivated by the fact that unknown solutions often cannot be observed directly. Under some restrictions on unknown right-hand sides of equations and errors in observations, we define the set consisting of those solutions and right-hand sides of such equations which are compatible with observation data and then we choose the optimal solutions among them. As an optimality criterion, we use the guaranteed deviation between the estimates of solutions or right-hand sides of differential equations and their exact values. Supposing that unknown perturbations of right-hand sides of equations and errors in observations belong to some special sets, we show that the optimal estimates of unknown right-hand sides of equations or their solutions can be obtained in terms of solutions to some periodic linear systems of ordinary differential equations with impulsive conditions at points of observations.

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THE INTERPOLATION PROBLEM AND SYSTEM OF NONLINEAR EQUATIONS IN EUCLIDEAN SPACES

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In identification problems of an object based on observation of its reaction to input signals particularly interesting is case when this information is not enough. A monograph [1] contains fundamentals of general operator interpolation theory in abstract Hilbert spaces: the number of interpolation nodes m and the degree of the polynomial n are not related. In Euclidean space as proven in [2], the number of interpolation nodes can be chosen smaller than the dimension of the polynomial space and the solution of this problem is unique. In [3] it is shown that the solvability conditions of the system of linear algebraic equations and the solvability conditions of the interpolation problem for the many variables function are equivalent under the corresponding notation.

In this paper, we obtain the conditions of existence of the solution for a system of nonlinear (polynomial) equations. If the degree of equation k is odd number, then the conditions for the solvability of the nonlinear system are equivalent to the conditions for the solvability of the interpolation problem in Euclidean space. In the case of k - even number, it is necessary to fulfill the additional conditions obtained in [4].

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INVESTMENT SOLUTIONS WITH GREENFIELD AND BROWNFIELD IN GEORGIA

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Greenfield Investments is an investment aimed at creating a new enterprise abroad from scratch or expanding an existing one. Such investments are carried out by large international corporations and are supported by local authorities, creating jobs for the local population. Underdeveloped countries offer low tax rates, subsidies, access to various resources and other benefits that stimulate new investment, on the one hand, reducing tax breaks for the national government, but on the other hand, it helps the state create new jobs. ... The country acquires knowledge, experience and technology, which ultimately leads to the growth of qualified personnel in the national economy. Interesting elements of new investments are: introduction of new technologies, training of qualified personnel, development of new markets and export growth. However, the disadvantage of this type of investment is that such companies produce goods and services cheaper, and local firms cannot compete and leave the market, in addition, the host country cannot benefit from the profit from production, because this profit comes from the country. in which he invests. The study was commissioned by the Tbilisi Municipality and funded by the World Bank in 2017 by British expert John Burroughs, who specializes in urban planning and the transformation of former industrial zones - Brownfields. Over the years, the man “led investment strategies for the redevelopment of the former industrial estates - Brownfield. Everything related to this. The study examined the scale of the former industrial zones ("Brownfields") in Tbilisi and discussed the proposals proposed in the draft land-use master plan for the city. They also focused on possible approaches to the Brownfield problem and projects that could benefit the city in the future. For research purposes, defined as: property likely to have been used in the past and which may be difficult to reuse or develop in the future due to the presence of hazardous substances or pollutants); Percentage of territory owned, the most common categories of environmental pollution.

The report says the Brownfield site is a production site for former large factories that are no longer in use. These enterprises operated during the Soviet period until 1991, when they supplied products to

other countries of the Soviet Union and to an extent that far exceeded Georgia's current demand. These territories were associated with the Soviet economy, which no longer exists. Some very large concrete buildings are empty today and it is surrounded by many acres of abandoned and empty land. The Brownfields area in the center of Tbilisi should be seen as an opportunity. The area of "Brownfields" in Tbilisi is not precisely estimated. The area is estimated at 1,500 hectares, but needs clarification The study identified 60 "abandoned fields" in Tbilisi, 70% of which are located in the south and southeast of the city (south and southeast of the Isani and Samgori railways and metro stations). These areas make up 80% of the total number of "abandoned fields" of the capital in the southern and southeastern parts of Tbilisi. 13.5% of Tbilisi's Brownfield area is located in the north and 6.5% in the center of Tbilisi, of which the area adjacent to the Central Railway is the largest and most important.

As an alternative to Greenfield Investment, we could consider Brownfield Investment, which involves the acquisition and / or lease of an existing facility by a company or government to launch a new production. An example of such an investment is the acquisition of a foreign car company (French Michelin) by a local car company (eg German BMW). This strategy also has a number of features that are properly prepared for the required process. When acquiring an operating company, the buyer acquires the right to manage it, the right to personnel, technology, trademark, marketing networks, etc. All links of the acquired company continue to operate and integrate into the international space. This strategy requires strengthening the productive forces.

Conclusion. Due to the great economic importance of foreign direct investment, they are regulated both nationally and internationally. At the national, state level, foreign direct investment is regulated by the provision of state guarantees.

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THE ROLE OF THE INVESTMENT DECISION IN THE INVESTMENT PROCESS

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Enterprises need investments for various reasons, which can be divided into three types: updating the existing material and technical base; Increase production volume; Mastering new types of activities. Investments are associated with obtaining franchises. At the same time, as a rule, it is believed that people should be excluded from receiving benefits, they act "rationally", but what does this mean? The answer to this question is inevitably a matter of theory and practice: to know the sea and then get rid of it. The economic model for obtaining an investment receipt has several features in common: Unnatural people with natural disabilities receiving investment incentives Bass.

The level of responsibility for obtaining an investment project varies. For example, it is quite easy to decide to replace an existing device with a more modern one, because it is now clear what types and features of new instruments are needed instead of the old one. When an investment project involves an expansion of the main business, it is more difficult to make a decision, since there are many new factors to consider. For example, how will the position of the enterprise in the market change, because if the demand for the goods produced by the enterprise is calculated incorrectly, the new volume of production may bring the enterprise a loss instead of a profit. You should also consider access to material, labor and financial resources, etc. The expected volume of investments is also important, because the responsibility for accepting an investment project is different, the volume of which is, say, $ 100 thousand, and, of course, the responsibility increases if the volume of investments is one million or more. That is why a manager in a joint-stock company has the right to make an independent decision on a relatively small amount, and all important decisions must be agreed and approved by the board of directors. The financial resources of any enterprise are limited, so it is necessary to optimize investment

decisions. When a decision is needed in the case of several alternative or independent projects, it is important to make the right choice based on criteria accepted in international practice, although the intuition of the curator is also important. Investment decision making is based on a variety of formal and informal methods. There is no one-size-fits-all method that can be used in all cases. Management is probably more of an art than a science, although formal assessment makes it easier for the manager to make the final decision. The risk factor is important in investment activities, since these activities are carried out under conditions of uncertainty, the quality of which varies considerably. It is rather difficult to accurately determine the economic effect.

Any investor strives to ensure that the capital invested by him gives the maximum profit, that is, the costs incurred by him give the maximum effect. In this case, costs are understood as investments, and in the results - incomes received as a result of the operation of the investment project. The time interval from the start of the project operation to its liquidation is the life cycle of the project. Usually, investment companies have alternatives to several investment projects. The main limitation of their implementation is the possibility of financing these projects. Therefore, it is necessary to choose the most optimal project from those presented. The feasibility of an investment project is determined by comparing the costs of implementing the project and the results obtained.

At this time, the following conditions must be observed:

1. Comparable investment costs and results should be measured in the same amount;

2. Comparable units are expressed in the same currency. It can be the national currency of a given country or a freely convertible and relatively stable currency of any other state (for example, the dollar or the euro);

3. In an unstable economy, against the background of constant price volatility, it is necessary to take into account inflationary processes when comparing investment investments and the results obtained. The use of such methods is recommended if the inflation rate of the national currency exceeds 5-6% per year 1;

4. Any project is implemented within a certain period of time, since funds are not equivalent to each other in different periods of time, the time factor must be taken into account when comparing investments and the results obtained. It is at this time that they use discounting.

Conclusion. When making an investment decision, it is necessary to take into account the interests of all participants in the investment project. In our opinion, two parties must necessarily participate in investments, both of which must be equally interested in the final result. The investor must be able to choose the right partner, take into account risk factors and the final result - profit. The host must create appropriate conditions such as a safe environment with minimal impact of corruption in the area of operation. Instead, the other side gets the opportunity to revive this or that sector, to get the proper equipment or tools, jobs, which will ultimately improve the socio-economic environment of the host side. Thus, the best option should be obtained when both parties share the positive result of the investment. An important role in decision-making is played by the structure of the capital that will be attracted for the implementation of the investment, although it is impossible to calculate everything with mathematical formulas, it is necessary to take into account the human factor.

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THE CONCEPT OF THE INTELLIGENT AUTOMATED SYSTEM FOR DIAGNOSTICS OF THE QUALITY OF ELECTRIC POWER

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The public power grid, which is operated by the utility, was originally designed to receive electricity from one source: the operating company's generators and power plants, and feed it into the grid where consumers get it. In modern conditions, a number of customers use devices to generate electricity (solar panels, windmills, etc.), and to save costs (or to generate income) they also return energy to the grid. Since the electricity company is legally obligated to buy electricity generated by consumers, it wants to make sure it doesn't damage the grid. The network must now be measured and monitored to ensure that the power supplied to the network from other sources is of the same quality and standards that the client equipment expects from it. The research of L.A.

Kopylova [1] is devoted to the research and development of automated control systems by power supply and power consumption with the use of intelligent decision-making methods. With the decision of the optimal options for connecting renewable sources to the grid, he devoted his work to I.S. Goncharenko [2].

The tasks of managing the quality of electricity at enterprises of the agro-industrial complex is an important task for improving the functioning of electrical equipment. The uninterrupted operation of these devices affects the quality of agricultural production, as well as the service life of electrical equipment. These tasks should be built on the basis of:

• monitoring (continuous control) of power quality indicators at all levels of power consumption, information support of power supply to consumers, establishing requirements for the consumer and the system;

• application of the technology of synchronized vector measurements for monitoring and control of the quality of power supply (WAMS technologies), etc.

The conceptual foundations of creating an information and control system for diagnosing the quality of electricity consumers in agriculture using synchronized vector measurements are considered.

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COMPLEMENTING OF THE SALESMAN'S PROBLEM WITH ADDITIONAL CONDITIONS

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This paper proposes to supplement the classic task of a salesman with an additional restriction on the number of resources that can be transported by the agent. In particular, variants of the problem with one and several agents are considered.

The case with one agent in the system and with a limit on the number of supply resources is considered.

For the classical problem we add to the vertices of the graph G(V, E), an additional parameter that will display the required amount of resources to visit this vertex.

Modifying the objective function of the classic salesman problem, according to the condition that the agent in the system has a finite resource R, and each vertex has a parameter r_i, which must be satisfied.

$$F = \sum_{i \in I}^{n} \sum_{i \neq j,\, j \in I}^{n} d_{ij} x_{ij} + \left(\left[d \right]_{ik} + d_{kj} \right) * f \to \min \tag{1}$$

$$f = \begin{cases} 0, & r_j \le R \\ 1, & r_j > R \end{cases}, \tag{2}$$

Where – elements of the weight matrix (transition price), x_{ij} – elements of the binary matrix, where 1 is a sign of the transition from i in j, k - an index that corresponds to the point where you can replenish the resource.

The solution was obtained on the basis of the ant colony algorithm [1]. The algorithm is subject to change in cases where condition (2) is not performed. The agent must return to the resource renewal point and continue from this point.

It is proposed to supplement the classic problem of a salesman with an additional condition (2) on the limitation of the resource (certain goods, etc.) owned by the agent. Cases with one and several agents are considered, the implementation of the ant algorithm is modified, the corresponding software is implemented.

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HEURISTIC EVALUATION AS A TOOL FOR QUALITY CONTROL OF USER INTERFACE IN AN ELECTRONIC DOCUMENT MANAGEMENT SYSTEM

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In modern society, the practical application of IT technologies clearly occupies a leading position, in particular in the education field. New applications are being created. Among them there are such

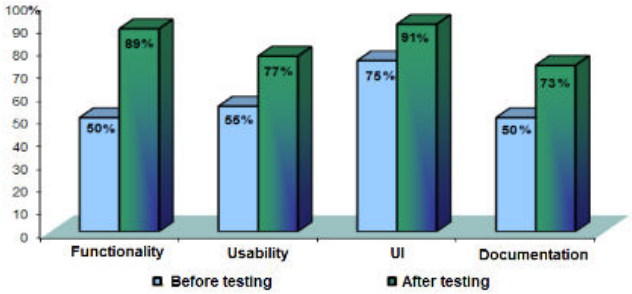
important ones as information systems of scientific report generation, which significantly free up teacher-researcher's time for a more creative process.

Each of such products requires appropriate quality assurance and ergonomic verification. User interface testing is a key step in the development lifecycle of a modern software product, which is often underestimated in an attempt to speed up the product development process. This is mainly due to the proliferation of a variety of CASE tools which make generating of code with an acceptable interface faster.

In this work, analytics of different types of testing is used to control and improve quality of a specific software product – statistical testing, manual testing, functional testing, usability testing, interface testing and documentation testing.

The above techniques are used for testing of an analysis and information system for generation of scientific reports of teachers of Ivan Franko National University of Lviv. Their main principles are based on the heuristics of Jacob Nielsen [1].

The information system passed a number of tests, during which shortcomings of its functioning were identified and corrected.



All the changes allowed us to improve the quality of this information system by applying the mentioned heuristics.

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A FUNCTIONAL LIMIT THEOREM FOR NESTED KARLIN'S OCCUPANCY SCHEME GENERATED BY WEIBULL-LIKE DISTRIBUTIONS

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Let $(p_k)_{k\in\mathrm{N}}$ be a discrete probability distribution for which the counting function belongs to the de Haan class Π. Consider a deterministic weighted branching process generated by $(p_k)_{k\in\mathrm{N}}$. A nested Karlin's occupancy scheme is the sequence of Karlin's balls-in-boxes schemes in which boxes of the j th level, j=1, 2, … are identified with the j th generation individuals and the hitting probabilities of boxes are identified with the corresponding weights. The collection of balls is the same for all generations, and each ball starts at the root and moves along the tree of the deterministic weighted branching process according to the following rule: transition from a mother box to a daughter box occurs with probability given by the ratio of the daughter and mother weights.

Assuming there are n balls, denote by $K_n^{(j)}$ the number of occupied (even hit) boxes in the j th level. We shall discuss a functional limit theorem for a vector-valued process $\left(K^{(1)}_{\left[e^{T+u}\right]},\ldots,K^{(j)}_{\left[e^{T+u}\right]}\right)_{u\in\mathbb{R}}$ for each $j\in\mathbb{N}$ properly normalized and centered, as $T\to\infty$. The limit is a vector-valued process whose components are independent stationary Gaussian processes. We shall provide an integral representation of the limit process.

The talk is based on a joint work with Z. Kabluchko (Münster). This paper is available at https://arxiv.org/abs/2104.06948.

AUTOMATED SYSTEM OF MULTI-CHANNEL TELEMONITORING OF TIME SYNCHRONIZATION SIGNALS OF ELECTRIC POWER NETWORKS OF SMART-TECHNOLOGIES

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Reliability and quality of operation of modern production, supply and use of electricity depend on the processes of their management, which take place in real time. Time synchronization signals (TSS) are used to solve time uncertainty in integrated power grids of SMART technologies. The formation of TSS and ensuring control of their quality indicators is an important and certainly relevant issue.

The synchronized signals formation quality control device (SSFQCD) which original technical decisions are protected by patents of Ukraine is developed, in an automatic mode carries out processingof TSS quality indicators measurements digital data and transfers them by means of telecommunication systems. The automated system of multi-channel telemonitoring receives, stores, processes in real time the results of the TSS time characteristics digital measurements and provides visualization of data necessary for decision-making in the operation of electricity networks both in normal conditions and in emergencies.

The technique and corresponding schemes of the TSS multichannel telemonitoring automated system measurements are developed. A laboratory stand was built, which includes SSFQCD and P4000winXP software, which was developed in the Embarcadero RAD Studio XE2 2012 environment. Experimental researches of the laboratory stand with use of GPS satellite systems receivers are carried out. The research results confirm the possibility of implementing the proposed ideas and working hypotheses, which in the case of practical implementation will increase the reliability and SMART-technologies electricity networks energy efficiency.

OPTIMAL TRANSPORT ALGORITHMS AND WASSERSTEIN BARYCENTERS

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The work considers the question of finding the optimal algorithm that will be used to solve the problem of finding Wasserstein's distance. The relevance of the research topic is that today these algorithms are among the most common ways to use optimal transport and are used in neuroscience when the processing of many images by traditional methods is impractical and resource intensive. In such cases, the use of optimal transportation algorithms is the solution. The purpose of the work is to determine the most efficient algorithm of optimal transport. To do this, several algorithms are considered and programmed, including the extrapolation from the past, the modified Tseng extragradient method and the algorithm of mirror descent of Malitsky. These algorithms were analyzed for the problem of finding the solution of variational inequalities in the form:

$$\left(A^T\left(Ax-b\right), y-x\right) \geq 0 \quad \forall y \in X$$

Where X- closed convex set of Hilbert space, and Δ - simplex.

It was found that a single universal algorithm is difficult to find. Each of the algorithms has its strengths, for example, Tseng's algorithm produces fewer iterations and, consequently, has more error, while Malitsky's algorithm is more accurate but consumes more iterations.

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ON THE PIECEWISE HYPERPLANE CLUSTERING METHOD FOR SOLVING RECOGNITION PROBLEMS

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One of the important problems of classification and clustering of information is the problem of minimizing the dimension of the space of features, the choice of criteria for optimal solutions in the processes of practical use. Similar tasks have effective solutions by empirical data on objects' proximity multidimensional scaling, when dimension of the measured objects essential characteristics space is determined and the configuration of points (objects in this space) is constructed. The space is some multidimensional scale resembling the ones that are commonly used in different applications in sense of certain positions on the new space' axes correspond to the measured objects' specially generated essential characteristics values [1].

Systems' synthesis mathematical algorithms developing to solve classification and clustering problems when using the objects characteristic features information is the purpose of the work. For solving the problem, to construct hyperplanes in space derived from source features' space and to use pseudo inverse perturbation and projection matrices and solutions of systems of linear algebraic equations theory is proposed [2]. Approach for the piecewise hyperplane cluster synthesis for the most effective characteristic features allocation and the algorithm for the piecewise hyperplane clusters constructing, which allow you to find effective solution to solve the problems, are suggested. Functionality and efficiency of the proposed approach is demonstrated using characteristic features scaling example to recognize the letters of fingerprint alphabet of sign language.

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RANDOMIZED BLOCK ALGORITHMS FOR VARIATIONAL INEQUALITIES

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We look at variational inequalities (VI) which are set in very high-dimension space. The operator in the inequality could be non-deterministic and be noisy or come as expectation over some random mapping. The constraint set for the problem is assumed to be a Cartesian product of lower-dimension sets.

Our motivation is as follows. The need to solve VI could come from the desire to find Nash equilibrium in non-cooperative games in uncertain regimes or from multi-agent decision making problems in which each agent wants to optimize their function.

To solve such variational inequalities block variants of classic well-known algorithms have been proposed. For example, randomized block stochastic mirror-prox algorithm was analysed by F. Yousefian, A. Nedic, U. V. Shanbhag [1]. Inspired by their work, we suggest block variants of other algorithms, such as past extra-gradient (Popov's), optimistic gradient (Daskalakis' et al) and reflected gradient (Malitsky's) algorithms [2-4]. Then we test such algorithms on VI with monotone and strongly monotone operators. We conclude that their performance is quite promising and needs further theoretical analysis.

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PARAMETRIC IDENTIFICATION OF ASSETS DYNAMICS MODELS

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If we are constructing the optimal initial investment portfolio for its known desired return [1], the algorithm of optimal diversification is as follows:

1. If we know a set of reachability $D(t,s,M)$ [2] control system [1], we can answer the question of transferring the control system to a given phase state $r_p^*(t)$ for a fixed point in time $t < s$.

2. Convert the system [2] at a given time to a given set N in phase space. This problem obviously has a solution if and only if $N \cap D(t,s,M) \neq 0$.

3. Find such control $u(t)$ and such vector $r_p(s) \in M$ at which the optimum value of a functional is reached $J = F(r_p(t))$, $t < s$.

The problem of paragraph 3 with determined criterion can be formulated as the problem of finding the minimum of the functional on the set of reachability

$$F^* = \min_{r_p \in D(t,s,M)} F(r_p(t)).$$

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ON THE QUESTION OF IMPLEMENTATION OF THE INFORMATION SECURITY UNIT OF THE USER INTERFACE FOR SEMI-NATURAL MODELING SYSTEMS

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The protection of the semi-natural modeling system (SPM) from unauthorized access depends on the efficiency of the information security unit of the user interface, including the authentication unit. The most promising means of controlling access to the system is considered to be the identification of the user by his biometric parameters. These include keyboard handwriting, which is a dynamic behavioral biometric characteristic of a person. The method of recognizing keyboard handwriting or analyzing the dynamics of keystrokes is used to enhance password authentication. It is economical, as it does not require the purchase of additional devices to remove the characteristics, user-friendly, allows for covert monitoring.

Despite numerous publications in this area, existing software and hardware implementations have a high probability of errors, so the continuation of research in this area is relevant.

An approach to creating an information security unit of the SPM user interface based on the use of the ontology model of the subject area "Authentication based on the method of keyboard handwriting recognition" is proposed. This approach is versatile, provides the ability to expand the content essence and functionality of the SPM user interface. It also allows you to quickly create an interface taking into account the characteristics of user tasks and the characteristics of a particular user, while increasing the efficiency of the semi-natural modeling system. In general, the task of creating an ontology model involves taking into account a set of different factors and relationships between them that affect the accuracy of user identification: user experience; keyboard type; operating modes; user model, theoretical methods of analysis of keyboard handwriting recognition and handwriting characteristics; the influence of external factors on the user's characteristics and others.

INFORMATION MODEL OF PROCUREMENT DECISION-MAKING SUPPORT ALGORITHM

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In order for the customers to be able to make effective decisions during procurement procedures, they have to perform a certain algorithm. Making an effective decision creates the base for the high level of satisfaction with the requirements of goods, works or services. If we analyze the steps of procurement algorithm, we will be assured, that this process is almost identical for every single customer, but when it comes to specific procurement activities, they are individual and they always have their own – individual characteristics. The client, or in our case the decision maker (DM), makes specific decisions based on the following requirements: What is the purpose of acquiring the goods, is it a necessity to purchase the goods (services) and how much can be spent on it?

In order to implement an effective decision-making algorithm in the procurement process, we think it is advisable to create an information field to facilitate this process in advance, (Figure 1).

Here is a list of abbreviations used in Figure 1:

Algorithm realization archival database (DB)

- **DLR -** Database of Legislative Regulations;
- **PAR DB**- Procurement activities regulated by a database of local documents;
- **DLR -** Database of Legislative Regulations;
- **PAR DB**- Procurement activities regulated by a database of local documents;
- **PADB** - Procurement application database;
- **DB FD**-Database of financial documents;
- **DB PDD**- Database of procurement decision-making documents;
- **DB PAR**- Database of procurement appeals and its results;
- **PRD DB** - Procurement Report Document Database.

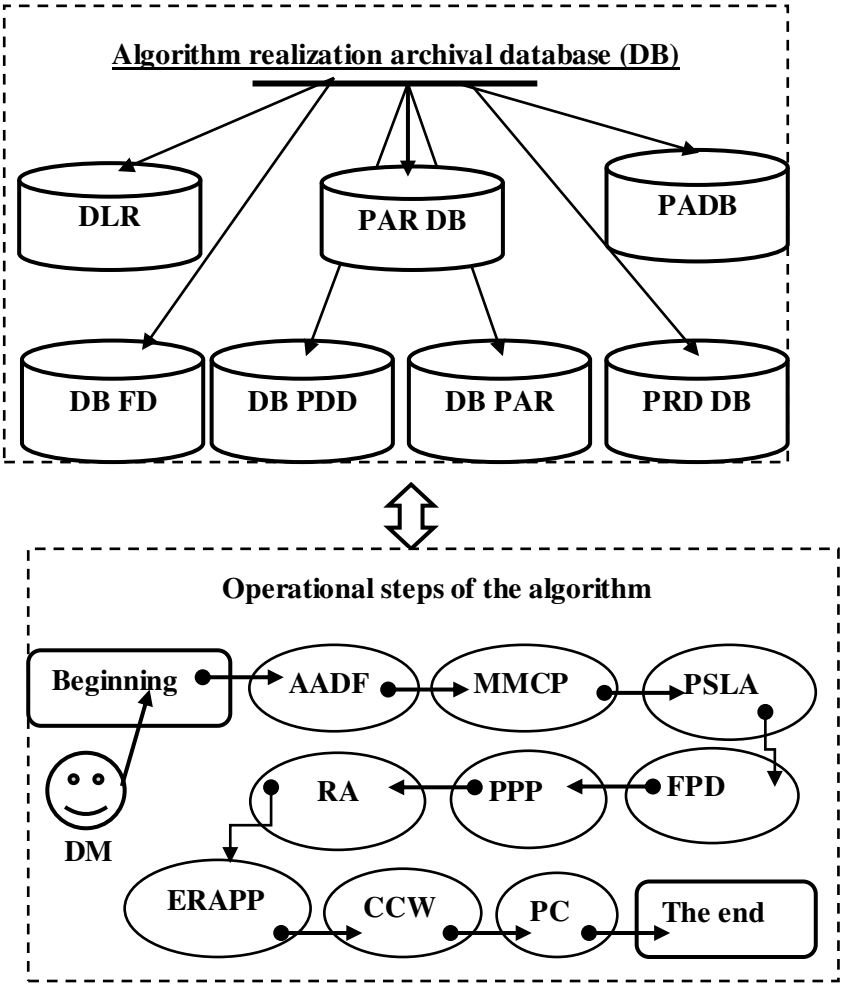

Figure 1. Information field of decision-making support algorithm.

Operational steps of the algorithm

- **DM** - Decision maker
- **AADF** - Production activity analysis and market demand formation;
- **MMCP -** Market monitoring and the review of commercial proposals;
- **PSLA** - Planning short and long term procurement activities;
- **FPD** - Formation of procurement documents;
- **PPP** - Publishing the procurement procedure on the Internet;

- **RA**- Receiving applications;
- **ERAPP** - Evaluating and reviewing received applications, arrangeing procurement protocols;
- **CCW** - Concluding a contract with the winner of the procurement;
- **PC** – Performance of contract

ON MOMENTS OF MULTI-CHANNEL QUEUEING NETWORKS WITH PERIODIC INPUT

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The object of our interest is a service process in a multi-channel stochastic network. It is a vector process with its entries equal to numbers of calls at the network nodes at time t. We assume that input flow is a non–homogeneous Poisson flow with rate depending on time periodically. In the work we obtain moments of the service process in transient regime. So, the main model is a queuing network consisting of the r service nodes. From the outside a periodic non-homogeneous Poisson flow of calls $\nu_i(t)$ arrives to the network. $\Lambda(t) = \int_0^t \lambda(u)du$ is its leading function. An arrived call is directed for service to the i-th node with probability p_{0i}, $i = 1,2,...r$. Each of the network nodes operates as a multi-channel stochastic system. Service time in the i-th node is exponential with parameter μ_i, $i = 1,2,...r$. After service in the i- th node the call goes into the j-th node with probability p_{ij}, or leaves the network with probability $p_{ir+1} = 1 - \sum_{j=1}^{r} p_{ij}$. $P = \left\| p_{ij} \right\|_1^r$ is the switching matrix of the network.

Theorem. *For service process* $Q'(t) = (Q_1(t),...,Q_r(t))$ *in the* $[M_t \mid M \mid \infty]^r$ *-network the mean-vector and the correlation matrix are of the following form:*

$$EQ(t) = q(t) + P'(t)k,$$

$$R(t) = \Delta(q(t)) + \Delta[k'P(t)] - P'(t)\Delta(k)P(t),$$

where $Q(0) = k = (k_1,...,k_r)'$, $q_j(t) = \sum_{i=1}^{r} p_{0i} \int_0^t p_{ij}(t-u)\lambda(u)du$,

$q(t) = (q_1(t),...,q_r(t))'$, $P(t) = \left\| p_{ij}(t) \right\|_1^r = \exp\{\Delta(\mu)(P-I)t\}$, $I = \left\| \delta_{ij} \right\|_1^r$ *is an identity matrix and* $\Delta(x) = \left\| \delta_{ij} x_i \right\|_1^r$ *is a diagonal matrix for a vector* $x = (x_1,...,x_r)'$.

For vectors $Q'(s) = (Q_1(s),...,Q_r(s))$ *and* $Q'(t) = (Q_1(t),...,Q_r(t))$, $0 \le s < t$, *the correlation matrix is of the following form:*

$$R(s,t) = P(t-s)\Delta(q(s)) + \Delta[k'P(s)]P(t-s) - P'(t)\Delta(k)P(s)P(t-s).$$

LEARNING TO RANK ON AGGREGATED DATA IN REAL TIME

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The problem of learning to rank has been intensively studied recently due to broad variety of important practical applications, from classical problems of multi-criteria choice of alternatives and decision-making to modern ones, such as information search and retrieval, machine translation, computational linguistics [1]. We consider on-line data stream ranking learning problem using training data in the form of a sequence of items series, described by a number of features and relative rank within the series. The complexity of solving this problem is connected with the need to use nonlinear models of ranking functions with an uncertain structure and a possible change in the relative ranks of items under the data obtaining.

In this regard, we also use ranking learning on clusters approach [2], based on preliminary clustering of ranking items followed by ranking function model building. Kernel-based learning approach is applied to construct a nonlinear model of the ranking function. To reduce the complexity of ranking model, it is proposed to build a kernel-based ranking function model in the space of aggregated data, which are clusters in features space, which also characterized by some averaged ranks [2].

Recurrent regularized algorithms for estimating the parameters of ranking function model as well as recurrent ranking learning algorithm in the space of conjugate variables are developed. Learning on-line

clustering algorithm includes cluster parameter and average clusters rank estimating.

The development of this approach is also considered, based on semi-supervised clustering methods in feature space with partial use some subset of additional data describes relative ranks [3].

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ABOUT OPTIMAL THRESHOLD STRATEGIES FOR STOCHASTIC SYSTEMS WITH QUEUE AND REPEATED CALLS

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A significant part of the queueing theory is the results on of systems with repeated calls. These systems are considered in detail in [1], [2]. In this paper a multiserver retrial queueing system with the finite number of servers, a finite length queue and an infinite orbit is considered. We deal with a Markov model of the system with repeated calls and queue with variable rate of input flow controlled by threshold strategies. At first for such system the existence conditions of stationary regime are pointed out. Further analysis is based on the approximation of the initial systems by the ones with limited orbit for which explicit vector-matrix formulas of stationary probabilities are found. We obtained effective calculating algorithms for the characteristics of the systems in stationary regime in terms of parameters of the systems. For threshold control strategies the optimization problem of the total revenue of the system was stated and solved. The rate of convergence of stationary distribution of finite system involved one server and one place in the queue to this of infinite system under threshold strategies was obtained. A numerical example of solving optimization problem for a stochastic system is given. The program allows determining the optimal strategies for changing the parameters of the system, depending on the specified

quality functional. The results of the paper can find application for solving modern practical problems that arise during the creation and operation of mobile communication systems, computer networks, call centers. The program can be applied to solve optimization problems for different adaptive control strategies.

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SYSTEMS ANALYSIS OF INTELLIGENT BIG DATA GOOD PRACTICE WITHIN THE FRAMEWORK OF MEDICAL AND BIOLOGICAL PROCESSES

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Once medical and biological data started to grow exponentially a decade ago, it has shown no signs of slowing down. It‘s aggregated mainly via the electronic medical records, hospital and laboratory information systems, internet, including social networks, web search requests, text messages, media files, IoT devices and sensors. Now, the world is powered by big data. Companies in the field of healthcare are forcing to seek experts in big data for consultations, capabilities to harness complex data processing.

The big question is how to harness the power that Big Data gives us with the purpose of diagnostics, treatment and prophylaxis. The most significant obstacle preventing organizations from realizing the full potential of their data assets is the widespread data disorder. Healthcare has quickly accumulated big massive of data, and adopted the environments to store them. Large amounts of data are generated and analyzed by various professionals in healthcare. At the same time, the

demand for Big Data professionals with a competences in medical and biological areas increases.

Project Innovations for Big Data in a Real World (iBIGworld) aims to join together HEIs, business in order to address the Big Data problems including healthcare solutions. This collaboration will provide innovative solutions to develop BigData experts in medical area. In this context, this project aims to analyze good practices based on Big Data for medical and biological processes. Moreover, key problems arising in the field will be displayed.

The work was co-funded by the European Union's Erasmus + Programme for Education under KA2 grant (project no. 2020-1-PL01-KA203-082197 "Innovations for Big Data in a Real World"

ON SUMS OF FUZZY NUMBERS WITH FUZZY SETS OF OPERANDS

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Assume that fuzzy numbers (FNs) f_j, $j \in N$ with the corresponding membership functions (MFs) $\varphi_j(x_j)$ are defined on the real line $\square$, where $N = \{1,2,...,n\}$ is the index set and n is the cardinality of the set N. Let $\tilde{N}$ be a fuzzy set on the set N of summand indices with the arbitrary MF $\eta(j)$, $j \in N$. In [1] was proposed the sum of fuzzy numbers f_j, $j \in N$ with the fuzzy set $\tilde{N}$ of summands. It was shown that the resulting set is a type-2 fuzzy set (T2FS). The type-2 MF of this set was constructed. The sum T2FS can be decomposed according to secondary membership grades into the corresponding collection of FNs. It helps to represent the addition operation on FNs with a fuzzy set of summands in a form which is convenient for a proper understanding and applications. In this report we intend to discuss different applications of this operation.

There are many real-life situations (ranging from global problems to everyday ones) in which there is a need to calculate such sums. For instance, let f_j be a FN that expresses an expert estimate of the greenhouse gas emission of the country $i \in N$, where $N = \{1,2,...,n\}$ is the set of countries, n is the cardinality of N. Assume that

$\tilde{N} = \{(i;\eta(i)) : i \in N\}$ is a fuzzy set of 'rich' countries with MF $\eta(i)$, $i \in N$. Then one may ask what is the total greenhouse gas emission of 'rich' countries? This is an example of the sum of FNs f_j, $i \in N$ with the fuzzy set ('rich' countries) $\tilde{N} = \{(i;\eta(i)) : i \in N\}$ of summands. Estimating primary expenses when planning a family budget yields yet another example of the sum of FNs that express the approximate costs of food, rest, entertainment, etc. with the fuzzy set 'Primary budget items' of summands.

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MODERN CONSTRUCTION SOLUTION OF FRICTION DIAPHRAGM IN THE MONOLITHIC REINFORCED CONCRETE BUILDINGS

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Earthquakes are one of nature's most violent events. Earthquakes outnumber all kinds of natural disasters in terms of casualties and devastating effects. Even today man is powerless in the face of this disaster. Even today, earthquakes cause great casualties, destruction, and loss [1].

From an economic point of view, it is recommended to take additional seismic measures for monolithic buildings in order to reduce the maximum movements and deformations of the load-bearing frame of the building.

Earthquake protection systems play an important role in increasing the seismic resistance of buildings, although they have their pros and cons [2]. From an economic point of view, the diaphragm is proposed as an active seismic element of tall buildings. To do this, a useful model of a new type of friction diaphragm is presented, which will significantly reduce construction costs, as well as increase the seismic resistance of the project buildings. The presented seismic insulation can be widely introduced in the construction of new buildings, which is facilitated by the proposed simple type of installation technology.

It is known from the literature that friction or friction diaphragms were used in prefabricated reinforced concrete buildings. This diaphragm consists of two panels of reinforced concrete, between which may be a layer of elastic material that provides energy absorption during oscillations caused by seismic impact. The friction diaphragm structure consists of two reinforced concrete panels, where one panel is attached to the lower rail and the other is attached to the upper rail. The panels are connected to each other with bolts in several places, and a layer of elastic material is placed between them [3]. During oscillation, these two paired panels move relative to each other, resulting in friction between the large surfaces of the diaphragm panels, which promotes energy absorption.

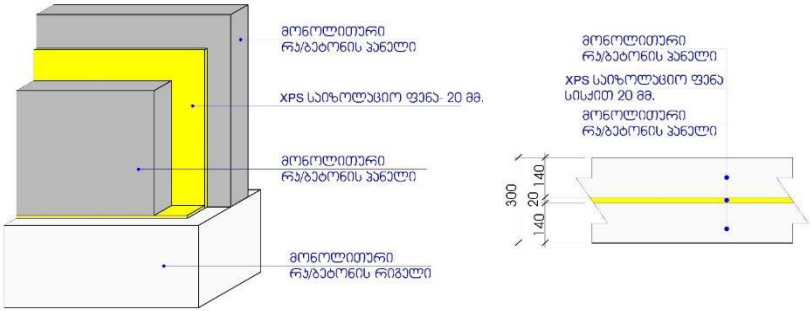
The new utility model of friction diaphragm is presented on the same principle, with the difference that the new model is an integral part of monolithic reinforced concrete, i.e. it is concreted together with other structural elements of the building and the construction of the building is a single body, a single structure. And a modern type of insulation layer (XPS - 2 cm.) is placed between the reinforced concrete panels. Also its installation technology is different.

Because the panels have to move against each other during a seismic impact to create friction between them, one panel needs to be connected only to the lower floor rail and the other to the upper floor rail, for which they need to be concreted separately.

According to the modern practice, during the construction process, the rigels and roofing slab are concreted simultaneously, which simplifies the construction process. Therefore, for the panel to be connected to the lower floor rail, it is necessary to arrange the reinforcement before concreting the slabs and slabs and only then pour the concrete at floor level. This single panel will then be concreted and vibrated. After removing the formwork, a modern insulation XPS layer should be placed on the given tile according to the schematic drawing presented.

As for the upper floor: the floor level and the second panel formwork must be arranged at the same time. The function of the formwork of one page of the second panel will be performed by the panel itself, which is already concreted by this time and the piece of page is covered with insulating material. This vertical element will then be concreted and vibrated, and only then concrete can be poured on the floor level.

3D visualization Section



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BI-HAMILTONIAN STRUCTURE AND EXACT SOLUTIONS OF ONE BURGERS' TYPE NONLINEAR DYNAMICAL SYSTEM

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Bi-Hamiltonian systems play an important role in the study of completely integrable nonlinear dynamical systems. In the present work, we find the bi-Hamiltonian representation as well as three classes of exact solutions for one Burgers' type three-component nonlinear dynamical system, which arises in the context of a dispersionful version of the so-called universal Whitham hierarchy. We begin with some important definitions from the theory of completely integrable nonlinear

dynamical systems, namely those of conservation law and its gradient and bi-Hamiltonian representation of a system. After that, for the above-mentioned dynamical system, we construct the infinite hierarchy of functionally independent conservation laws utilizing the gradient holonomic method. Moreover, based on that hierarchy we find the implectic pair of Noetherian operators and corresponding Hamiltonian functionals applying the differential-algebraic algorithm. Furthermore, we construct three classes of exact traveling wave solutions, in particular, solitary wave and periodic ones, using the (G'/G)–expansion method. It is shown that for the case of the dynamical system under consideration, the degrees of polynomials in (G'/G) cannot be uniquely determined from the system of algebraic equations of the homogeneous balance. Nevertheless, utilizing a more detailed analysis, a general form of the solution is found uniquely. Further, we analyze the obtained results, in particular, the analytical solution is verified by putting it back into the original equations. Finally, we anticipate future research objectives, especially finding the standard Lax type representation of the above-mentioned dynamical system.

GUARANTEED ESTIMATES OF MATRIXES IN LINEAR REGRESSION PROBLEMS WITH SMALL PARAMETER

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Linear estimation of observations in order to obtain unbiased estimates is the subject of research in many scientific publications. The first publications on the linear estimation of observations date back to the end of the previous century [1-5], nowadays the interest in the subject remains [6].

Linear regression analysis problems in conditions when the components of the observation vectors are matrices, known of which are assumed to have small deviations from the calculated, studied in publications [8, 9]. Equations for unbiased estimates were investigated using pseudo-inverse operator technology as well as the perturbation method.

The linear estimation problem in space of rectangular matrices considered. Investigated equations for unbiased estimates using pseudo-inverse operator technology and perturbation method.

Problem formulation. Observed vector $y = CX + \eta, \quad y \in R^N$, $C -$ linear operator acting from matrix space $H_{m\times n}$ dimension $(m \times n)$ in vector space R^N, $X -$ unknown matrix belonging to a known set $G_0 \subset H_{m\times n}$, $\eta \in R^N -$ random vector for which $E\eta = 0,\ E\eta\eta^T = R$ ($E -$ symbol of mathematical expectation), $R -$ unknown correlation matrix from the set $G_1 = \{R : sp(QR) \le 1\}$, where $Q -$ known symmetric positively defined matrix, $sp(\cdot) -$ trace of the matrix.

Set the linear operator L, acting from the space of matrices $H_{m\times n}$ into finite-dimensional space H dimension s with basis $\bar{e}^i$, $i = \overline{1,s}$, $(LX, \bar{e}^i) = sp(X(L^*\bar{e}^i)^T) = sp(XD_i^T),\ D_i \in H_{m\times n},\ i = \overline{1,s}.$

The problem of finding linear unbiased estimates of the vector LX, guaranteed standard error of the linear estimate and the guaranteed rms estimate are solved.

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DECISION SUPPORT SYSTEM MODEL FOR ANALYSIS OF INFORMATION SPREADING PROCESSES

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One of the intelligence analysis' tasks is to minimize the rate uncertainty during solving decision-making problems and researching social processes. This purpose provides using approaches and methods for operational or strategic estimation and forecast of processes' dynamics. Information systems nowadays support and simplify processes of providing information, knowledge, and digital products [1]. Therefore develop the decision support system for intelligence analysis is an urgent problem. It is troublesome to realize because interactions in a social sphere are difficult to formalize [2]. In this work, we adduce base concepts for creating the decision support system (DSS) model of information spreading processes. The development of these systems is base on the Deming-Shewhart cycle as a known PDCA (plan-do-check-act) method for continuous improvement of products [3]. It guarantees the outcome as the system that adequately represents the subject area for decision-makers' investigation. We offer the passive DSS on the base of a two-level data warehouse [4]. Such systems aim to help decision-makers investigate a subject area. But they do not suggest particular ways of solving the problem. The model base in a DSS allows the users to select a mathematical model to represent the studied information spreading process. Then decision-makers choose the method of analysis depending on the type of the model and their own goals. For example, systems of differential equations expedient to use for the analysis of the general dynamics.

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PROBLEM ANALYSIS OF MANAGEMENT AND DECISION MAKING IN BUSINESS UNDER REMOTE MANAGEMENT

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Today, due to the world problems caused by the coronavirus pandemic, businessmen have to function in a difficult situation, which makes business management inefficient and negatively affects the socio-economic development of the country. The business environment has changed significantly, it has become necessary to find the alternative ways of decision-making. The challenges in these conditions have led to the development of a complex set of scientific approaches to business. In such a situation, in order to maintain competitiveness in the market and manage a successful business, it is crucial for the businessman to possess special skills, in particular, well-adapted decision-making methods and, most importantly, modern electronic means of communication. It is obvious these means primarily include remote electronic communication technologies, which ensure to make the right choice from alternative offers and make an effective management decision while working in groups with business partners.

It should be noted that the remote form of business management and decision-making has significantly reduced a number of costs, such as: transportation costs of service personnel, office rent and utility costs, maintenance costs of service personnel, etc.

We should consider this as a positive fact that will push businessmen to analyze this situation and change the existing organizational forms of business management after the pandemic and bring it compliance with remote business management. The reduction in costs listed here lies on the surface, its analysis does not require any scientific calculation. As for the negative developments that will be caused by the inefficiency of remote business management and decision making; it is a long process and manifests itself in the not too further future, which will become an irreversible and irreparable process. This negative phenomenon can overwhelm the pros of remote work and cause unpaid the loss to the business. Therefore, in order for a businessman not to take the wrong step and manually move to a remote form, it must first build a formalized model of forecasting tasks and conduct relevant research. To achieve the efficiency of business remote control, first of all, it is necessary to make the most of modern computer technologies, the latest

models and methods of management and decision-making, even at the level of artificial intelligence itself.All this requires highly-qualified and experienced staff - programmers and IT (information technology) specialists, whose knowledge will determine the fate of the business. The latter, it is a deficit in business. The tasks that these specialists have to solve on a daily basis are shown in Fig.1.

The report discusses the main problems of remote management of the business during and after the pandemic, highlighting the positive and negative aspects of remote operation. There are defined the following:

- Risks of decision making;
- The need for new tactical and strategic thinking and the formation of a corporate culture;
- The need to change the criteria and approaches for evaluating the effectiveness of managing business structures and decision-making in the new environment;
- New forms of relationships with business partners.

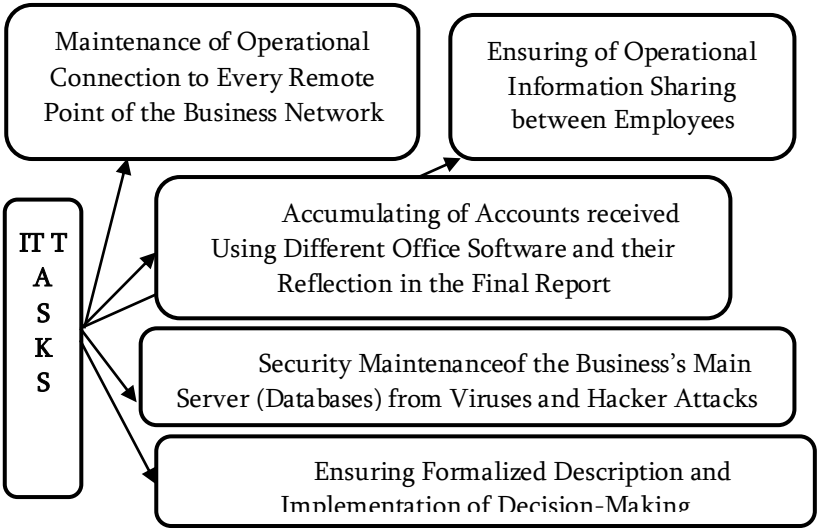

Fig. 1. - IT Tasks

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PROBLEMS OF MAKING RESOLUTIONS IN THE PROCESS OF PROFESSIONAL TRAINING OF STUDENTS IN TERMS OF THE PANDEMICS

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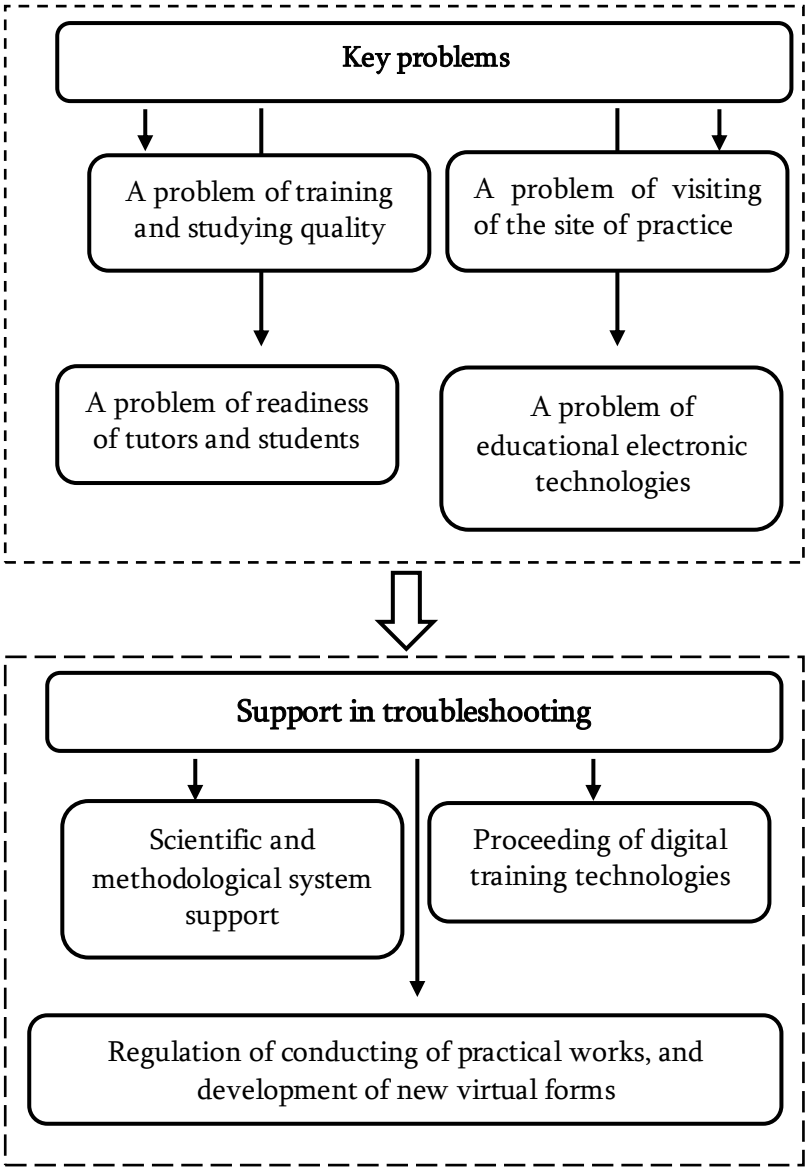
Enforced transferring of the secondary professional educational system on the remote mode of operation against the background of the pandemics seems to be a very difficult process. A complex of huge organizational and pedagogic problems has vividly appeared that created difficulties in making resolution in relation to management of the educational processes. A key essence of the problem is represented by the fact that a majority of professional trainings of students, for the purpose of strengthening of the theoretic course, should be devoted to conducting of practical works on a definite site. For the purpose of conducting of practical works in a distant mode we should apply adequate contemporary electronic imitation modules or training devices of the site which, in practice, have not been obtained by the educational system, their implementation requires a long period of time, large expenditures and intellectual resources.

As all are aware, we deal with an extreme state that creates uncertainties. It is clear that in such circumstances making of efficient resolutions of management of educational process is hindered. Based on our research we determined key problems which are characteristic in this view and have a negative impact on making of efficient resolutions in the process of secondary professional education, Picture 1.



Picture 1. Problems and assistance in their settlement

BOUNDARY VALUE PROBLEM FOR THE COMPOSITE TYPE EQUATION WITH NONLOCAL BOUNDARY CONDITIONS ON A PLANE SEMI-BAND

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The work is devoted to the study of the boundary value problem for the second order composite type equation obtained by differentiating the first order elliptic type Cauchy-Riemann equation on the semi-band.

Namely, we consider the following problem

$$\frac{\partial^2 u(x)}{\partial x_2^2} + i\frac{\partial^2 u(x)}{\partial x_1 \partial x_2} = 0, \qquad x_1 \in (0,1), \quad x_2 \in (0,\infty), \tag{1}$$

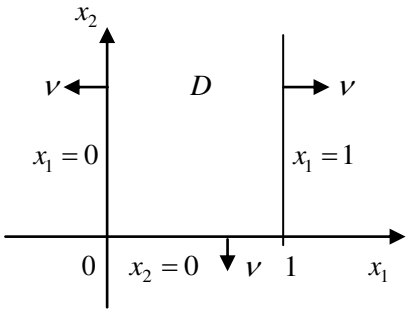
$$\alpha_{k1}(t)u(0,t) + \alpha_{k2}(t)u(1,t) + \alpha_{k3}(t)\frac{\partial u(x)}{\partial x_1}\bigg|_{\substack{x_1=0\\x_2=t}} + \alpha_{k4}(t)\frac{\partial u(x)}{\partial x_1}\bigg|_{\substack{x_1=1\\x_2=t}} +$$

$$+\alpha_{k5}(t)\frac{\partial u(x)}{\partial x_2}\bigg|_{\substack{x_1=0\\x_2=t}} + \alpha_{k6}(t)\frac{\partial u(x)}{\partial x_2}\bigg|_{\substack{x_1=1\\x_2=t}} = \alpha_k(t), \quad k=1,2;$$

$$t \in (0,\infty), \tag{2}$$

$$\frac{\partial^k u(x)}{\partial x_2^k}\bigg|_{x_2=0} = \beta_k(x_1), \qquad x_1 \in [0,1], \quad k=0,1, \tag{3}$$

where $i=\sqrt{-1}$, $\alpha_{kj}(t)$, $k=1,2$, $j=\overline{1,6}$, $\alpha_k(t)$ $k=1,2$, $t\in[0,\infty)$ and $\beta_k(x_1)$ $k=0,1$, $x_1\in[0,1]$ are given continuous functions, boundary conditions (2) are linear independent.



As is known, the fundamental solution to equation (1) has the form

$$U(x-\xi)=\frac{1}{2\pi}\ln\left[x_2-\xi_2+i(x_1-\xi_1)\right]. \qquad (4)$$

Multiplying equations (1) by the fundamental solution (4) and integrating over the domain $D=\left\{x=(x_1,x_2);x_1\in(0,1),x_2\in(0,\infty)\right\}$ and applying the Ostrogradsky-Gauss formula, we obtain the first basic relation.

Further, multiplying equation (1) by the derivative $\frac{\partial U(x-\xi)}{\partial x_1}$ and integrating over the domain D, similarly to the previous one, we obtain the second basic relation. Finally, with the multiplication of equation (1) by $\frac{\partial U(x-\xi)}{\partial x_2}$ and integrating over the domain D, we arrive at the third basic relation.

Each of these relationships consists of two parts.

The first part of which gives solutions to equation (1) and its first derivatives defined on the semi-band. The second parts of these basic relations present the necessary conditions.

These necessary conditions contain singularities, which are regularized in a peculiar way, using a given boundary condition.

Further, the obtained regular relations together with the given boundary conditions lead to the sufficient condition for the Fredholm property of the considered boundary value problems.

SIMULATION AND ANALYSIS OF MOVEMENT FLOW OF VEHICLES USING RANDOM EVOLUTIONS UNDER THE POISSON APPROXIMATION SCHEME

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Various methods are used to model traffic flows that can be simulation game models, network graphs, computer programs, or equations, in particular, deterministic or stochastic. Reasonable probabilistic approaches to the construction of traffic flows are described, in [2] and references. We also offer a probabilistic model,

we consider the position and speed of the whole flow. Obstacles can usually be of two types - those that cause a slow deceleration and those that lead to sudden braking. Then an adequate tool for studying such a transport flow can be a stochastic equation, which takes into account the perturbations of both types [1], [3] - [5]:

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

where C is velocity function, ε is a small series parameter; $x(t/\varepsilon^2)$ is uniformly ergodic Markov process

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ECG ANALYSIS WITH HIGH PRECISION AND RECALL

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As stated in [1], there task of Real-time Health Monitoring is actual one. At the same time, the most health problems are connected with the Cardio-Vascular System (CVS) diseases. And, the most of them could be prevented via monitoring and continuous analysis with early problem signals reactions followed.

There are many uncertainties: noisy signal, the quality of a device and of connection to a body, the quality of post-analysis is not obviously good enough, and even provability of the obtained results is not self-explanatory. Many challenges, hackathons and R&D Projects were held

and developed to approach the solution of satisfiable quality. One of these competitions is 2017 PhysioNet Challenge [2] with 8528 ECG to analyze and to build the appropriate model to split normal cardiograms from those with arrythmia. There are many good results obtained during analysis of these data, including [3].

Here we propose the following method for analysis. Its stages are the Hamiltonian localization and extraction of R-peaks, followed by the analysis of a number of indicators (Rhythm, SDNN, R-R Moda, AMo, MxDMn, IN) [2], and then training of the Decision Tree for ECG classification by these selected and pre-calculated parameters.

Provided method leads us to the results, which have better precision + recall characteristics, and F1 measure of 0,9 for arrythmia, which is greater than the best of previously known (namely, 0,87) [3].

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STRATEGY FOR PLANNING UNDERGROUND INFRASTRUCTURE OF LARGE CITIES IN CONDITIONS OF UNCERTAINTY AND MULTIFACTOR RISKS

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One of the characteristic features of the modern world is the growth of metropolises, the expansion of infrastructure and the growth of their population. Regulation of the urban development with the purpose of increasing ecological standards and life safety in constantly growing metropolises is one of the most urgent, though insufficiently researched and difficult world problems. It is leads to the search of new places to production facilities, social and other objects of human activity. The

space of megacities created by man in the process of underground construction becomes a new, underground habitat, which should be comfortable and safe for humans.

The strategy for planning underground infrastructure of large cities based on the mathematical support of foresight methodology with the aim of scenarios alternatives creating and cognitive modelling to build scenarios for the development of the desired future and ways of their implementation is proposed. For realization of this strategy the system approach to solving of the developing socio-economic problems taking into account the totality of the properties and characteristics of the studied systems, as well as the features of the methods and procedures used to create them is developed [1].

A significant advantage of cognitive models is that their composition at different stages and levels of study and description can include both quantitative (for example, "hydrostatic pressure") and qualitative (for example, "socio-economic feasibility") characteristics. Imitation of cognitive modelling, especially at the stage of design work on the development of the underground space, is extremely necessary. A serious reason for this may be the fact that it is necessary to anticipate and eliminate or reduce risks in advance which are inevitably inherent in underground urban planning in conditions of uncertainty.

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STATISTICAL SIMULATION IN TRAFFIC ANALYSIS PROBLEMS

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The concept of "Internet of Things" (IoT) is one of the most modern trends in the development of telecommunication networks and information systems. The range of theoretical and practical issues is very wide. The telecommunication network should be developed in such a way as to provide all the necessary conditions for the practical application of the concept "Internet of Things". One of these conditions is to maintain of multiservice traffic with specified quality indicators.

This traffic can be considered as a sum of two components representing different IP packet flows.

The first component is sometimes called the traffic of people (as a rule, a person becomes a user), the second is the traffic of things created by the implementation of the IoT concept. The properties of the first component are being actively studied by experts in telecommunication traffic theory based on theoretical models and measurement results in operating multiservice networks. The study of the second component is complicated by the fact that it is still difficult to predict the nature of the growth of IoT traffic with the required reliability.

In the paper the methods of statistical simulation of the main distributions were considered, which are used to create "Internet of Things" traffic. Investigating the multiservice traffic it should be taken into account the possible change in its nature as the number of end devices through which the concept of "Internet of Things" is implemented.

In the coming years, the volume of IP packets related to Internet of Things traffic will be increased. A special interest in the study of multiservice traffic is paid to the distributions of interarrival times IP packets, which are determined at the finite time interval. The study of such distributions provides a new class of problems in the theory of teletraffic with practical significance.

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SOLVABILITY OF THE FRACTIONAL CAUCHY PROBLEM IN THE SPACE OF DISTRIBUTION

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Let $Q_T^n = \{(x,t): x \in \mathbf{R}^n, t \in (0,T]\}$, vector $\gamma = (\gamma_1,\ldots,\gamma_n)$ – multi-index, $(\partial/\partial x)^\gamma = (\partial/\partial x_1)^{\gamma_1}(\partial/\partial x_2)^{\gamma_2}\cdots(\partial/\partial x_n)^{\gamma_n}$. Denote:

$$D_b(\mathbf{R}^n) = \left\{\varphi \in C^\infty(\mathbf{R}^n): (\partial/\partial x)^\gamma \varphi \quad is \quad bounded \quad in \quad \mathbf{R}^n \quad \forall \gamma\right\},$$

$$D^0(\overline{Q}_T^n) = \left\{\varphi \in C^\infty(\overline{Q}_T^n): \quad (\partial/\partial t)^p \varphi\Big|_{t=T} = 0 \quad \forall p = 0,1,2,\ldots\right\},$$

$D_b(\overline{Q}_T^n) = \left\{ \varphi \in D^0(\overline{Q}_T^n) : (\partial/\partial t)^p (\partial/\partial x)^\gamma \varphi \quad \textit{is bounded in} \quad \overline{Q}_T^n \quad \textit{for all} \right.$

$\left. p = 0,1,2,\ldots \quad \textit{and} \quad \forall \gamma \right\}$; $D_b'(\overline{Q}_T^n)$, $D_b'(\mathbf{R}^n)$ – the spaces of continuous linear functionals on $D_b(\overline{Q}_T^n)$ and $D_b(\mathbf{R}^n)$.

We consider the fractional Cauchy problem:

$$(D_t^\alpha u)(x,t) - Au(x,t) = g(x,t), \quad x \in \mathbf{R}^n, \quad t \in (0,T], \tag{1}$$

$$u(x,0) = u_0(x), \quad u_t(x,0) = u_1(x), \quad x \in \mathbf{R}^n, \tag{2}$$

with distribution $g \in D_b'(\overline{Q}_T^n)$, $u_0,\ u_1 \in D_b'(\mathbf{R}^n)$, where $\alpha \in (1,2)$, $(D_t^\alpha u)(x,t) = \dfrac{1}{\Gamma(2-\alpha)} \left(\dfrac{\partial}{\partial t} \right)^2 \displaystyle\int_0^t \frac{u(x,t)}{(t-\tau)^{\alpha-1}} d\tau$ is the Riemann–Liouville operator [1]; A is a second order elliptic differential operator with smooth coefficients in $\mathbf{R}^n$. We applied the methodology of work [2] for proof of theorem of existence and uniqueness of the solution of the problem (1),(2).

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ON THE BEHAVIOR OF SOLUTIONS OF A SYSTEM OF TWO CONJUGATE DAMPING OSCILLATORS

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Consider the system of two harmonic oscillators with friction, which is described by a system of two linear second-order differential equations

$$\begin{cases} \ddot{u}_1(t) + 2h_1\dot{u}_1(t) + k_1^2 u_1(t) = 0, u_1(0) = u_{10}, \dot{u}_1(0) = \dot{u}_{10}, \\ \ddot{u}_2(t) + 2h_2\dot{u}_2(t) + k_2^2 u_2(t) = 0, u_2(0) = u_{20}, \dot{u}_2(0) = \dot{u}_{20} \end{cases}$$

where - u_{io}, $\dot{u}_{i0}$ the initial position and velocity of the oscillators; $k_i > 0$ - the parameters of the oscillators and $2h_i$ - coefficients of friction of oscillators; $u_i(t)$, $\dot{u}_i(t)$ - position and velocity of the oscillators at the time $t > 0$, $i = 1,2$.

The study of the behavior of the imaging point M on the phase plane during random perturbations along the phase velocity vector, in the case of one harmonic oscillator without friction, was carried out in [1]. For the case of harmonic oscillators with friction perturbed by Wiener processes, the study of the behavior of the imaging point M at (damping oscillatory process) was carried out in [2].

In this article the behavior of the solutions of two conjugate harmonic oscillators under the random perturbations of the "white noise" type of the Ito form is investigated. The explicit form of the amplitude, phase of the system of damped oscillators is found. The behavior of the amplitude, phase of the system of damped oscillators is investigated.

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SIMULATION OF FINANCIAL STABILIZATION FOR UKRAINIAN CLASSICAL UNIVERSITIES IN THE CONDITION OF THE GLOBAL PANDEMIC COVID - 19[a]

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In this paper, we focus on the mathematical problem of financial stabilization for Ukrainian classical universities activity in the condition of the global pandemic COVID - 19. The problem is to choose a control law that provides the required accuracy of the system to achieve the

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specified indicators for any initial conditions from a given set for a limited time. Controls that solve a formulated problem are called stabilizing. The task of optimal stabilization is to find the existence conditions for the optimal stabilizing control and to construct the methods for its calculation.

First, we consider the problem of studying the relationship of economic factors and indicators that affect the activities of the university, which is a key point for making informed stabilization decisions. To further determine the parameters of modeling the financial stabilization of classical universities (the case of Taras Shevchenko National University of Kyiv), we conduct a preliminary intelligence analysis of data, which consists of three sequential stages: selecting the set of factors and parameters, identifying the most influential ones and preliminary statistical analysis. Finally, we construct an adequate econometric model for making strategic stabilization decisions.

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TOUGH FINANCIAL DECISION MAKING OF UNIVERSITIES UNDER THE CURRENT CHALLENGES [b]

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This paper is intended to provide an insight into the importance of adaptive financial decision making of universities under the changing environment producing the new and unprecedented challenges. Universities, like any other organizations, developed the system with a range of tools and techniques to assist the administration in consistently

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making financial decisions, i.e. evaluating the resource allocation. Realigned with a process and procedure, the tools and techniques form the framework for a support system for financial decision making.

The discussion will call upon the variety of ordeals in the educational sector to review and improve the approaches and detailed measures taking into account the university performance and the cash flow problem. As universities around the world lose a certain list of supporting income (parking fees, food sales, etc.), they also face unexpected costs, including partial reimbursement of fees, accommodation, and meals, and the need to scale virtual learning and work methods.

The paper builds upon the approach to show how universities can financially adapt to the changing conditions of the COVID-19. It provides an important source to analyse different types of support for solving problems of financing education during challenging times.

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ON THE PROBLEM OF EXPLICIT REPRESENTATION OF STATE-DEPENDENT RETRIAL QUEUES STEADY STATE PROBABILITIES

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In this presentation, we consider Markov models for two types of multiserver retrial queues with varying input flow rate. From a practical standpoint, such systems are of special interest. The input flow rate in such systems depends on the number of repeated calls in the current moment of time. This allows to control the input flow in order to maximize the quality of service, eliminate the possibility of overflow, maximize the income from the system, etc. Despite the widespread and

practical importance of the retrial queueing systems analytical representation of the steady state probabilities were obtained only for the simplest cases.

First, we present results for classical state-dependent models. Next, we consider state-dependent queues with limited number of retrials. For both systems, the conditions for the existence of the stationary regime are formulated. We develop approach for the analysis of retrial queues with controlled input flow rate by the systems with limited phase space. For classical systems and systems with a limited number of retrials, this approach allows finding explicit formulas of vector-matrix type for probability characteristics of the truncated system.

The presented results allow to estimate various integral characteristics of the of the multi-channel retrial queue with controlled input flow, to state and solve optimal control and optimization problems with wide class of control policies.

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A CONDITIONAL LIMIT THEOREM FOR A CRITICAL BRANCHING PROCESS WITH THE MIGRATION

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Consider a Markov branching process with one type of particles and migration $\mu(t)$, $t \in (0,\infty)$ [1]. Let $\mu(t)$ denote the number of particles at the time $t \in (0,\infty)$.We suppose, that at the time $t = 0$, the process starts with one particle $\mu(0) = 1$.

The process $\mu(t)$, $t \in (0,\infty)$ then $\Delta t \to 0$ is given by the transition probabilities.

We note that p_k $(k=1,2,...)$ is the intensity of the reproduction particle, q_k $(k=1,2,...)$ is the intensity of immigration, and r_n $(n=1,2,...,m)$ is the intensity of emigration and m is a fixed integer.

We introduce the following notation

$$f(s)=\sum_{k=0}^{\infty} p_k s^n,\ \ g(s)=\sum_{k=0}^{\infty} g_k s^n,\ \ |s|\le 1,\ s\in C.$$

Random process $\nu(t)$, which describes the behavior of the process within the Period-Life. [2]

Theorem. Let $g(0)<0,\ \ g'(1)=a_1<\infty,\ \ f'(1)=0,\ \ f''(1)=2b_0<\infty,$ and $0<\lambda=a_1 b_0^{-1}\le 1$, then

$$\lim_{t\to\infty} P\left\{\frac{\nu(t)}{b_0 t}\le x \middle| \nu(t)>0\right\}=1-e^{-x}$$

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TOPOLOGY OF STRUCTURALLY OPTIMAL MORSE FLOWS ON 3-DIMENSIONAL HANDLEBODY

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We consider Morse flows with one source, one sink, and all other singular points on the boundary of a three-dimensional handlebody and without saddle connections. In addition to the source and the sink, there are two more types of singular points, which are saddles when the flow is restricted to the boundary. The stable manifold has the dimension 1 for the 1-saddle and it has the dimension 2 for the 2-saddle.

We construct a complete topological invariant of the flow. To do this, consider the intersection of a neighborhood of the union of stable manifolds of 1-saddles with the interior of the handlebody. There are two types of arcs on the resulting surface: 1) its intersection with unstable manifolds of 1-saddles; 2) its intersection with stable manifolds

of 2-saddles. Thus, the invariant consists of a surface and two types of arcs. The flow will be optimal if the arcs do not intersect.

Let us stand the dual graph to the given embedding of arcs. The vertices of the graph correspond to the regions into which the arcs break the surface, and the edges correspond to the arcs. Thus, the edges are of two types in accordance with the two types of arcs and we paint them in two colors. In addition, at each vertex, a cyclic order of the edges adjacent to it is defined in accordance with their counterclockwise traversal (in accordance with the orientation of the surfaces).

Definition. The graph constructed in this way is called the discriminating flow graph.

Theorem. Two flows are topologically equivalent if and only if there is an isomorphism of their distinguishing graphs that preserves the color of the edges and the cyclic order of the edges at the vertices.

Morse flows on a complete torus are topologically equivalent, and there are 5 different optimal flow structures on a handlebody of genus 2.

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DYNAMIC DECISION-MAKING FOR CRYPTOCURRENCY RATE STABILIZATION BASED ON THE IMPULSE PROCESS MODEL IN THE COGNITIVE MAP

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In this report a cognitive map (CM) of the cryptocurrency in the financial market has been developed based on causal relationships. This is a weighted directed graph with nodes reflecting: the cryptocurrency rate, the volume of cryptocurrency trading, the number of cryptocurrency users, the volume of capitalization, the volume of investments, the volume of speculation in cryptocurrency, supply and demand for cryptocurrency, indirect profit, level of confidence in

cryptocurrency, variance of the cryptocurrency rate, integral level of risks when using cryptocurrency.

On the basis of the CM, a dynamic model of CM impulse processes is developed in the form of a system of difference equations (Roberts equations [1]). The external control vector for the CM impulse process is selected. It is formed by varying the resources of the following CM nodes coordinates: cryptocurrency supply, trading, capitalization, investment and speculation volumes. Controls are designed in a closed-loop control system of the impulse process based on the automatic control theory methods and are implemented by a decision-maker. A closed-loop control system for the CM impulse process is implemented, which includes a multidimensional discrete state controller synthesized on the basis of the modal control method, which generates the selected control vector and directly affects respective CM nodes by varying their coordinates.

The report solves the problem of a stabilization system design for the unstable transient process of the cryptocurrency rate based on the modal control method. An identification system for the CM weights based on the recurrent least squares method has been developed. The options of modal control with two, three and five controls in the CM with 12 nodes are investigated.

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SIMULATION OF FBM AS INPUT SIGNAL ON THE LINEAR SYSTEM

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We consider a generalized Wiener process (fractional Brownian motion, FBM) with the Hurst index $H \in (0,1)$ $W_H(t), t \in [0,1]$. It means that $W_H(t)$ is Gaussian process such that $W_H(0) = 0$, $EW_H(t) = 0$ and with covariance function

$$R_H(t,s) = \frac{1}{2}\left(|t|^{2H} + |s|^{2H} - |t-s|^{2H}\right).$$

We suppose that FBM is an input process to a time-invariant linear system with real-valued square integrable impulse response function, defined on a domain [0,T]. The response on the system is an output process.

One of the important aspects of using a simulation model is the possibility to assess the adequacy of the obtained results as expected from the model conditions.

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.

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PREDICTING TEMPORAL DEPENDENCY BETWEEN MORTALITY AND INCIDENCE RATES USING DYNAMIC TIME-LAG REGRESSION MODEL

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In this report, we consider a problem of modelling the temporal dependency between two temporal processes, namely mortality and incidence of a particular disease (e.g. cancer), where the former one is caused by the latter one. Traditional approach to the problem of prediction includes use of age-period-cohort model [1, 2], age-period log-linear models [3], or competing risk models [4], but they involve analysis of incidence or mortality data alone, not both. We use approach proposed in [5] – dynamic time-lag regression model – which allows to include non-stationary time delay between $i(t)$ (incidence at time t), mortality $m(t+\Delta t)$ at time $t+\Delta t$, when both the value $m(t+\Delta t)$ and the time lag $t+\Delta t$ depend on $i(t)$. A Bayesian approach is used to tackle the specifics of the problem.

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ABOUT CONVERGENCE OF THE OPERATOR EXTRAPOLATION METHOD

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Many important problems of operations research, optimal control theory and mathematical physics can be written in the form of variational inequalities. Non-smooth optimization problems can be solved effectively if they are reformulated as saddle problems, and modern approximate algorithms for solving variational inequalities are applied to the obtained saddle problems [1]. With the advent of generating adversarial neural networks (GANs), strong interest in the use and investigation of iterative algorithms for solving variational inequalities arose in the ML-community [2].

This report is devoted to the study of two new approximate algorithms with Bregman projection for solving variational inequalities in Hilbert space. The first algorithm, which we call the operator extrapolation algorithm, is obtained by replacing the Euclidean metric in the Malitsky–Tam method [3] with the Bregman divergence. An attractive feature of the algorithm is only one computation at the iterative step of the Bregman projection onto the feasible set. The second algorithm is an adaptive version of the first, where the used rule for updating the step size does not require knowledge of Lipschitz constants and the calculation of operator values at additional points.

For variational inequalities with pseudo-monotone, Lipschitz-continuous, and sequentially weakly continuous operators acting in a Hilbert space, weak convergence theorems are proved.

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DECISION MAKING PROBLEM RELATED TO CHARGING STATION FOR ELECTRIC TRANSPORT

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The mathematical model of estimation of efficiency of quantitative and technical-qualitative development (EEDM - Evaluation Efficiency Development Model) at the level of grid of charging stations for electric vehicles on the territory of the city of the following type is constructed:

$$EEDM=<T, L, \Phi>,$$

where T is a tree of indicators, which is shown in Figure 1.

Let F_0 – be the root vertex that reflects the main goal – to increase the efficiency of the development of the charging stations system. On the second level, we decompose F_0 on the sub targets F_s, s = 1, …, S, these are the criteria for placing charging stations. On the third level Ri, i=1, ... m, are districts of the city.

L – a set of qualitative assessments of the levels of each criterion and each district in the hierarchy T. At the same time: L = {Very low level (ДН), Low level (Н), Intermediate level (С), High level (В), Very high level (ДВ)}.

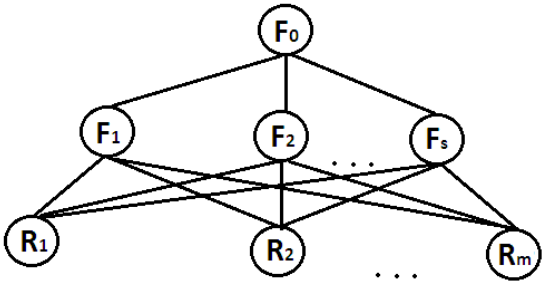

Figure 1. Metrics tree to evaluate development efficiency

To assess the effectiveness of the development of the system as a whole, the aggregation of indicators of each level of the hierarchy of the built model was carried out. The article proposed a decision support procedure for finding a comprehensive assessment and assessments at each level of the hierarchy (Figure 1).

FUNCTIONAL INTERVAL OF THE SOLUTION OF A GENERAL BOUNDARY VALUE PROBLEM

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Based on the mathematics of functional intervals [1], two-sided approximations of the solution of the general boundary value problem are determined, which definitely contain such the solution and are considerably narrower than the approximations obtained in [2].

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

$$\underline{k} \le y''(x) \le \overline{k} \qquad (1)$$

where $\underline{k}, \overline{k}$ are some constants; y_a, y'_a, y'_b are the value of the function $y(x)$ and its first derivative at the ends of the interval $[a,b]$, respectively. You need to find a functional interval of the solution of such a general boundary value problem.

We have constructed square parabolas, which graphs come through the point (a, y_a) and square parabolas, which graphs come through the corresponding points of the previous set of parabolas at the point $x = 0.5\,(a+b)$. It is proved that in the case when

$$0.5\,(\bar{k}+\underline{k})\,(b-a)+(y'_a-y'_b)=0 \qquad (2)$$

all the parabolas of the second set of parabolas at $x=b$ intersect at one point. When condition (1) is satisfied, the number $\underline{k}$ and $\bar{k}$ can always be chosen such that condition (2) is also fulfilled. On this basis, a functional interval is constructed, the width of which is considerably smaller than the width of the corresponding functional interval constructed in [2].

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NEWTON-SECANT TYPE METHOD WITH APPROXIMATION OF THE INVERSE OPERATOR

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Let consider a nonlinear equation

$$H(x)=0\,.$$

Here $H:D\subseteq X\to Y$ is a nonlinear operator, defined on a convex domain D, X and Y are Banach spaces. In general, H is a continuous operator, but it can be represented as the sum of two operators – differentiable and nondifferentiable, i.e. $H(x)\equiv F(x)+G(x)$, where F is a Fréchet-differentiable operator, G is a continuous operator.

For finding an approximate solution of the equation of this type we apply the differential-difference method, which contains the sum of the derivative of the differentiable part and the divided difference of the nondifferentiable part of the nonlinear operator. This combined method is based on the Newton method and the two-parametric secant type method [1]. At each step of iterative methods, it needs to calculate the inverse operator. This requires significant computational costs and it is not always easy to do. The proposed iterative process uses a one-step Schultz approximation of the inverse operator [2]. For certain choices of

numerical parameters, included in the considered method, it is obtained modifications of the Newton-secant method and Newton-Kurchatov method with a successive approximation of the inverse operator.

We provide a local convergence analysis of the differential-difference method under the Lipschitz condition for the divided differences of the first order and the bounded of the second derivative. As a result, we obtain the error estimates and the convergence order of the considered method.

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COMPLICATION OF SQL-INJECTIONS RESULTS ANALYSIS. PROBABILISTIC APPROACH

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We consider a probabilistic model of complication of SQL-injections results analysis ([1]). The process of SQL-injections results analysis is like a motion along the nodes of a deterministic graph. Each such node characterizes how far the hacker has advanced in his business, how much and what information he was able to obtain. Each node determines what next steps hacker will take. If we can detect the attack ([2]) and influence the results of responses to SQL-injections, then we can replace the deterministic model with the Hidden Markov model ([3]), which will not only complicate the definition of unobservable states, but, with alternating types of responses, will make it impossible to achieve the attacker's goal.

That sounds good. However, an experienced hacker can easily compromise the application of such protection. One can suspect such protection by different responses to the same SQL injection. Well, we understand that the database can change over time and the same queries to it can give different answers, but a hacker does not need to know that such a game is being played with him. It is enough for him to suspect it

and he will change his strategy. Then the problem turns into the plane of game theory.

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ON ONE METHOD EFFICIENT CONSTRUCTION OF THE HILBERT-SCHMIDT OPERATOR PROVIDING THE EQUIVALENCE OF TWO GAUSSIAN MEASURES IN THE HILBERT SPACE

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The paper considers two Gaussian processes that are solutions to different linear evolutionary differential equations in Hilbert space, excited by the same Gaussian process. In terms of the linear operators of the equations themselves and the characteristics of a given exciting Gaussian process, the Hilbert-Schmidt operator is constructed in an explicit form, which is the main criterion of Yu.L. Daletsky [1], which provides a necessary and sufficient condition for the equivalence of probability measures generated by Gaussian processes that are solutions of the considered linear evolutionary differential equations, since the exciting process itself is Gaussian, and the equation is linear.

Therefore, the measures generated by the solutions of these equations are also Gaussian. Applying now to these two Gaussian measures the theorem of Yu.L. Daletsky for this case, using our calculated Hilbert-Schmidt operator, we prove a theorem on the equivalence of Gaussian measures generated by solutions of the linear evolutionary differential equations under consideration and in explicit form in terms of the known coefficients of differential equations and in explicit form and in terms of known coefficients of differential equations the density Radon-Nikodim.

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STABILIZATION IN THE SYSTEMS WITH AFTEREFFECT

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The report deals with the questions of stabilization of control systems given by systems of linear differential equations with time-delay argument. It is known that the classical problem of stabilization of systems given by ordinary differential equations is considered as the construction of a control with a given spectrum and is called the problem of analytical controllers design. It is reduced to the problem of constructing a system with a given spectrum. When the controllability condition is satisfied, the problem is reduced to solving a non-degenerate system of linear algebraic equations and has a unique solution. The characteristic equation of the system of differential equations with time-delay has a countable number of eigenvalues. Therefore, a similar formulation of the spectrum control problem was not posed. If the system is a system with time-delay argument, then there is a line $\operatorname{Re}\lambda = N_0$ such that all eigenvalues are located to the left of this line. Moreover, the eigenvalues with a positive real part are not more than the dimension of the system. Therefore, for linear controllable systems with time-delay, it is possible to pose the problem of stabilization to a given degree (similarly to [1]), which is the problem of finding a control at which the spectrum is shifted to the left in such a way that $\operatorname{Re}\lambda_i \le 0$. The proposed report considers an algorithm for solving this problem.

In what follows, we consider the problem of optimal stabilization, i.e. construction of the stabilizing control in which the quadratic criterion of quality reaches a minimum value.

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MATHEMATICAL MODELING OF COVID-19 EPIDEMIC AND DATA ANALYSIS

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Mathematical modeling based on system of ordinary differential equations (ODEs) may provide a simple but comprehensive mechanism for the dynamics of different infection diseases such as influenza, HIV/AIDS, COVID-19, etc. [1]. Many modeling studies have already been performed for the COVID-19 epidemic. In this research, we analyze different types of susceptible-infected-recovered (SIR) family of compartmental models for modeling of spreading of COVID-19 disease [2].

A key problem in the mathematical modelling of epidemic systems consists of the identification of parameters of the model. Some of the model parameters can be evaluated from the clinical data. Some other parameters (or their combinations) are estimated by fitting the epidemiological data. It is worth noting that different combinations of model parameters can give a similar fitting accuracy [3]. Predictive ability of the epidemic model is limited by the accuracy of the available data.

The important role play sensitivity of various parameters involved with the epidemic model. Sensitivity coefficients are an integral part of the gradient-based optimization methods. In addition, sensitivity coefficients inform us how important each parameter is to disease transmission.

Results of numerical experiments with data of Covid-19 in different regions are presented. Model parameters was fitted by minimizing the sum of weighted squared errors between solutions obtained by the model and the reported cumulative number of infected cases. Some model parameters are considered as functions of time.

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APPLICATION OF SUBDIFFUSION PROCESSES TO OPTION PRICING

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Analysis of different financial markets shows that most of economical processes are far away from the classical *diffusion models* considered in financial mathematics.

The constant periods of stagnation in financial processes are analogous in nature to the trapping events of the subdiffusive particle. Therefore, the physical models of subdiffusion can be successfully applied to describe financial data. *Subdiffusion* occurs if we replace the calendar time t with $S(t)$, where $S(t)$ is called the inverse subordinate (hitting time) and is given by the following formula:

$$S(t) = \inf\{n > 0 : T(n) > t\}.$$

In this formula the subordinator is the activity time $T(n) = \sum_{i=1}^{n} \tau_i$, where τ_i has reciprocal (inverse) Gamma distribution $R\Gamma(\alpha, \beta)$.

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ANALYSIS OF THE SIRM-MODEL WITH BIRTH AND MORTALITY RATES

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The SIR model (Kermak-McKendric model [1]) is one of the basic models of the spreading infectious diseases in a population. It is a system of three nonlinear differential equations that reflect the dynamics of the number susceptible to the disease $S(t)$, $t \in (0,T)$, the number of infected individuals $I(t)$, $t \in (0,T)$ and the number of recovered individuals $R(t)$, $t \in (0,T)$.

We investigate the specific case of basic model with birth and mortality rates:

$$\begin{cases} \dot{S}(t) = -\alpha(t)S(t)I(t) - \mu_1(t)S(t) + \gamma(t), \\ \dot{I}(t) = \alpha(t)S(t)I(t) - \beta(t)I(t) - \mu_2(t)I(t), \\ \dot{R}(t) = \beta(t)I(t) - \mu_3(t)R(t), \\ \dot{M}(t) = \mu_2(t)I(t), \end{cases} t \in (0,T), \quad (1)$$

where $S(t)$ is the number of deaths from complications of infectious disease; $\alpha(t)$ is the disease transmission rate; $\beta(t)$ is the recovery rate; $\gamma(t)$ is the birth rate; $\mu_1(t)$, $\mu_2(t)$, $\mu_3(t)$ are the mortality rates in subpopulations. We found conditions for the system (1) when its solutions are non-negative.

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FINITE-VALUED RANDOM PROCESSES WITH CONTINUOUS TIME

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Let $P(t)$ – stochastic vector depending on the argument t, $t \geq 0$.

System of linear difference equations

$$P(t+h) = \sum_{k=0}^{N} \alpha_k(t) \Pi_k(t) P(t-kh), \quad (h \geq 0,\ t \geq 0) \quad (1)$$

defines some random process under the following conditions

$$\Pi_\kappa(t) \in L_s, \quad \alpha_k(t) \geq 0 \quad (k = 0,1,...N), \quad \sum_{k=0}^{N} \alpha_k(t) \equiv 1 \quad (t \geq 0) \quad (2)$$

More generally, the system of linear difference equations

$$P(t) = \sum_{k=0}^{N} \alpha_k(t) \Pi_\kappa(t) P(t - \tau_k(t)) \quad (\tau_k(t) \geq 0,\ t \geq 0) \tag{3}$$

also defines a non-Markov random process under conditions (2)

In the limiting case, in the system of equations (1) at $N \to \infty$, $h \to 0$ get a system of integral equations for a random process.

$$P(t) = \int_0^\infty \alpha(t,\tau)\ \Pi(t,\tau)\ P(t-\tau) d\tau \tag{4}$$

At the same time, we offer the fulfillment of the conditions

$$\alpha(t,\tau) \geq 0,\ \int_0^\infty \alpha(t,\tau) d\tau = 1,\ \Pi(t,\tau) \in L_s \tag{5}$$

Even more complex is the system of equations

$$P(t) = \sum_{k=0}^{N} \alpha_k(t) \Pi_k(t) P(t - \tau_k(t)) + \int_0^\infty \alpha(t,\tau) \Pi(t,\tau) P(t-\tau) d\tau\ , \tag{6}$$

where satisfied conditions

$$\Pi_\kappa(t) \in L_s\ ,\ (k = 0,1,...N)\ ,\ \Pi_\kappa(t,\tau) \in L_s \quad (t,\tau \geq 0)\ ,$$

$$\alpha(t) \geq 0,\ \alpha(t,\tau) \geq 0,\ \sum_{k=0}^{N} \alpha_k(t) + \int_0^\infty \alpha(t,\tau) d\tau = 1.$$

The system of equations (6) defines a certain non-Markov random process.

All systems of equations (1) – (6) can be written in general form

$$P(t) = Z(t) P(t-\tau)\ ,\ P(t) \in S_m\ , \tag{7}$$

where $Z(t)$ – linear operator mapping to stochastic vector $P(t-\tau)$ at $\tau \geq 0$ stochastic vector $P(t)$. Such an operator will also be called stochastic. In general, the operator $Z(t)$ can be non-linear.

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STUDY OF STABILITY OF SYSTEMS WITH DELAY WITH SWITCHING

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Systems with switching will be called systems consisting of dynamic subsystems representing differential subsystems with constant delays, operating at given time intervals, and difference subsystems, which determine switching in differential subsystems. The dynamics of the system can be recorded in the following formal form

$$S(F,G,T)=\left\{S_{ni}(f_{ni}),i\in I,S_{nj}(g_{nj}),j\in J,T:t_0<t_1<t_2<...<t_n<...\right\} \quad (1)$$

$$S_{ni}(f_{ni}):x'(t)=f_{ni}(t,x(t),x(t-\tau)),\ \ t_{n-1}\le t<t_n,$$

$$i\in I=(I_1,I_2,...I_n,...),$$

$$S_{nj}(g_{nj}):x(t_n)=g_{nj}(t_n-0,x(t_n-0)),\ \ j\in J=(J_1,J_2,...J_n,...).$$

$$T:t_0<t_1<t_2<...<t_n<...$$

and the initial conditions $x(t)=\phi(t)$, $t_0-\tau\le t\le t_0+\tau$. We will assume that the functions $f_{ni}(x(t),x(t-\tau),t)$, $i\in I=(I_1,I_2,...I_n,...)$ and $g_{nj}(x(t),t)$, $j\in J=(J_1,J_2,...J_n,...)$ belong to some classes of functions and satisfy zero conditions, i.e. $x(t)\equiv 0$ is a solution to system (1).

It is proposed to consider two types of systems.

1. Sequence of points in time $T:t_0<t_1<t_2<...<t_n<...$ and functions $f_{ni}(x(t),x(t-\tau),t)\in\Phi$ are known. Thus, the switched system is completely defined. Systems of this kind will be called systems with definite switchings.

2. Sequence of switching times $T:t_0<t_1<t_2<...<t_n<...$ and functions $f_{ni}(x(t),x(t-\tau),t)\in\Phi$, $g_{nj}(x(t),t)\in\Gamma$ or are not known, or they have to be in any way define. Thus, the switched system (1.1) is such that there are three uncertainties. Namely, in the classes of differential subsystems, in the classes of difference and in the switching times. Systems of this type will be called systems with indefinite switchings.

Constructive sufficient conditions for the asymptotic stability of switched systems are obtained.

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NON-STATIONARY PARAMETER ESTIMATION BY THE LEAST SQUARES METHOD WITH VARIABLE FORGETTING FACTOR AND LEAST DEVIATIONS FROM 'ATTRACTION' POINTS FOR NON-LINEAR DYNAMIC SYSTEMS UNDER UNCERTAINTIES

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The parameter identification problem of slowly time-varying vector α is considered for non-linear discrete dynamic object

$$x(k+1) = F(x(k),u(k),k)\alpha + g(x(k),u(k),k) + \xi(k), \quad k \in \mathbb{N}, \qquad (1)$$

when additionally for unknown vector α its 'attraction' point $\alpha_*(k)$ is known at any moment k, where $x(k), u(k), \xi(k)$ are state, control and disturbance vectors respectively.

The least squares estimate with variable forgetting factor $\lambda(k)$ $\left(\lambda(k) \in (0,1],\ k \in \mathbb{N}\right)$ 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

$$\operatorname*{Arg\,min}_{\alpha} Q(\alpha, N), \qquad (2)$$

where $Q(\alpha, N) = \sum_{k=1}^{N} w(k,N) \left\| \xi(k) \right\|^2$,

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

The required unique estimate $\hat{\alpha}(N)$ on estimate set (2) is proposed as least squares estimate with variable forgetting factor $\lambda(\square)$ and least deviation from given 'attraction' point $\alpha_*(N)$ at any moment N in this case.

Explicit and recurrent forms of representation are obtained for parameter estimate $\hat{\alpha}(N)$ of non-stationary vector α for non-linear discrete system (1) under these non-classical suppositions. The recurrent algorithm for corresponding weighted residual sum of squares is suggested too.

MODELING OF PROCESSES OF INTELLECTUAL COLLECTION, RECOGNITION AND TRANSMISSION OF INFORMATION IN SEMI-NATURAL MODELING SYSTEMS

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To solve the problem of developing algorithms for intelligent collection and transmission of information in semi-natural modeling systems, to build a model and tool for learning neural networks for character recognition, modern tools for modeling convolutional network technology (CNN - Convolutional Neural Networks) and generative competitive networks (GAN - Generative) were studied. Adversarial Nets).

It is proved how due to the improvement of GAN (models scaling) it became possible to create images with larger size and better quality.

Graphical representation of block diagrams belong to the class of graphological, in particular, patent documentation and contain a lot of such figures, for example, MS Office basic auto shapes. The figures have internal and external blocks of text and are connected through communication lines. These connections are between themselves and with the contour lines of the connection nodes.

Neural network models are proposed to increase the accuracy of block diagram node detection processes based on fully accessible and convoluted networks.

To recognize text blocks that are part of graphic primitives used a neural network that is previously trained to recognize the fonts used in the creation of such blocks. For this purpose the program of recognition

of figures from a set of a volume database of samples of handwritten writing of figures of the MNIST educational set is developed.

At the learning stage, graphic images and corresponding signatures should be created for each class of possible block diagrams for the selected angular step value for neural network recognition of the algorithm for traversing the contours of figures and branches of connections.

As a result of this work, it was proved that an increase in the level of error-free recognition can be obtained by reducing the promotion step and involving statistical processing of scan results.

BOUNDARY VALUE PROBLEM FOR AN EQUATION WITH SECOND-ORDER PARTIAL DISCRETE DERIVATIVES

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The present paper is concerned with the study of solutions to the boundary-value problem for a differential equation with second-order partial derivatives with a discrete additive derivative for one argument and a discrete multiplicative derivative for another argument.

Let's consider the boundary value problem:

$$D_2^{[1]} D_1^{(1)} y_{mn} = f_{mn}, \ 0 \le \mathrm{m} < M, \ 0 \le n < N, \tag{1}$$

$$y_{Mn} = a y_{0n} + \varphi_n, \quad 0 \le n \le N, \tag{2}$$

$$y_{mN} = b y_{m0} + \varphi_m, \ 0 \le m \le M, \tag{3}$$

where $D_2^{[1]} y_{mn} = \dfrac{y_{mn+1}}{y_{mn}}$ is the discrete multiplicative first-order derivative for the second index, $D_1^{(1)} y_{mn} = y_{m+1n} - y_{mn}$ is the discrete additive first-order derivative for the first index, a, b are the real constants, f_{mn}, φ_n and φ_m are the preset real-valued sequences, y_{mn} is the query sequence.

Proceeding from the definition of discrete derivatives for the general solution of equation (1), we have:

$$y_{mn} = y_{0n} + \sum_{s=0}^{m-1} \left(D_1^{[1]} y_{s0} \right) \cdot \prod_{k=0}^{n-1} f_{sk}, m \ge 0, n \ge 0. \tag{4}$$

Given the general solution in the boundary condition (2), we obtain:

$$y_{0n} = \frac{1}{a-1}\left[\sum_{s=0}^{M-1}\left(D_1^{[1]}y_{s0}\right)\cdot\prod_{k=0}^{n-1}f_{sk} - \varphi_n\right],\ n \geq 0. \qquad (5)$$

The same way, taking into account the general solution (4) in the boundary condition (3), we obtain:

$$D_1^{[1]}y_{s0} = \frac{D^{[1]}\varphi_s}{\prod_{k=0}^{N-1}f_{sk} - b},\quad s \geq 0. \qquad (6)$$

As can be seen from the above, the following statement has been established:

Theorem. If $a \neq 0$, $a \neq 1$, and $b \neq 0$ are preset positive numbers, f_{mn}, φ_n and φ_m are preset real-valued sequences fulfilling the condition $\prod_{k=0}^{N-1}f_{sk} \neq b$, $s \geq 0$, $b\varphi_0 + \varphi_M = a\varphi_0 + \varphi_N$, then a solution to the boundary value problem (1) – (3) is as follows:

$$y_{mn} = \frac{1}{a-1}\left\{\sum_{s=0}^{M-1}\frac{D^{[1]}\varphi_s}{\prod_{k=0}^{N-1}f_{sk} - b}\cdot\prod_{p=0}^{n-1}f_{sp} - \varphi_n\right\} + \sum_{s=0}^{m-1}\frac{D^{[1]}\varphi_s}{\prod_{k=0}^{N-1}f_{sk} - b}\cdot\prod_{p=0}^{k-1}f_{sp}.$$

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METHODS AND INFORMATION TECHNOLOGY OF DEVELOPMENT OF MOBILE THERAPEUTIC AND DIAGNOSTIC COMPLEXES

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One of the promising directions in the engineering of medical technology is the use of modern information technologies (IT) for diagnostics of the state of biological objects. The development and production of the autonomous electronic medical systems, devices and equipment designed for mobile use should be considered a priority area.

The paper discusses issues related to the development, manufacture and debugging of prototypes using the example of medical devices - system block diagrams of medical devices with microprocessor control, the structure and capabilities of debugging tools for programs for micro-controllers, prototyping of the analog part and the power supply [1].

Modern medical systems are complex integral technical devices manufactured according to the latest technologies on a modern element base, often contain computing and control tools that allow automating the process of obtaining diagnostic information and implementing therapeutic effects in the required form with a given duration.

Obtaining reliable diagnostic information is a serious problem effected by noise, interference and artifacts of various origins; in this case, the level of informative signals is of the order of nano-values, which is commensurate with or below the level of operating noise and interference. All this leads to a significant complication of technical devices; as a result, they are subject to increased requirements for measurement accuracy, sensitivity, reliability, electrical safety, low energy consumption, cost, etc.; at the same time, technical devices must be universal, interchangeable, unified, which makes it possible to apply modern repair and maintenance technologies to them.

During the creation process, the system is decomposed into hardware and software components (HW / SW partitioning). Decisions are made on the overall structure of the system (first of all, the number and characteristics of computing devices for software and hardware.

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METHODS AND TOOLS OF SEMI-NATURAL MODELING IN THE PROCESS OF CREATING COMPLEX OBJECTS

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When developing large information-measuring and control systems, it is advisable to first establish the interaction of different blocks of the system with each other. For this purpose, hardware-software modeling is applied at which blocks are as much as possible realized in the form of models, and realization of their interrelations is carried out by means of the special equipment which simulates their external signals and interfaces. The proposed approach is based on the division of the device into hardware and model units. Only those units whose operation needs to be investigated are realized in hardware form. Others are implemented in the form of universal models controlled from a computer. This reduces the cost of upgrading modules in case of unsatisfactory test results. It is also possible to study several information processing algorithms simultaneously. The ever-increasing complexity of the devices and the components used in them greatly reduces the efficiency of the layout. This is especially evident in the development of innovative devices, which require a lot of research and experiments. The need to create tools for semi-natural modeling is due to the ever-increasing complexity of controlled objects and processes while reducing the time to analyze the problem situation and the adoption of the necessary control effects.

The main tasks of semi-natural modeling are: conducting research and evaluation of technical solutions in the field of the structure of embedded real-time computer systems; evaluation of the characteristics of devices and their software; complex testing of equipment in solving problems of information interaction and applied problems of embedded real-time computer systems; check of serviceability of the equipment, including check of conformity of functioning of devices and data transmission channels to requirements of the technical task.

HARDWARE AND SOFTWARE AND THEIR ARCHITECTURAL AND STRUCTURAL ORGANIZATION TO CREATE A SYSTEM OF SEMI-NATURAL MODELING

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Simulink is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in automatic control and digital signal processing for multidomain simulation and model-based design.

ADS2 is a comprehensive, highly adaptable software environment and real-time hardware platform for prototyping, integration, testing, validation and verification of avionics in the aerospace industry, developed by TechSAT.

Simulink is a powerful software tool widely used in the aerospace industry. The ADS2 system implements a convenient and understandable interaction with Simulink for the development of computer models of components. In combination with the use of dBricks for storing data of communication protocols, it is possible to create an integrated chain of tools that significantly speeds up the development and debugging process. Wide joint application of Simulink and ADS2 is possible based on the following facts:

- All common ADS2 memory with all CVT points is available at all nodes of the ADS2 system.
- Any CVT point is accessible from any device of the ADS2 system.
- A C ++ API is available on ADS2.
- Simulink allows you to connect external C ++ code as a separate block (S-function).
- The S-function block allows you to change the state of its input-output parameter by an external command.

ON THE PROBLEM OF THE POLYNOMIAL EXTRAPOLATIONS CONVERGENCE

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Let $f_1, f_2, \ldots, f_n$ be any time-series, $x_1, x_2, \ldots, x_n$ are points of time respectively. It is needed to estimate the future observation f_{n+1} at the point $x > x_n$.

Proposition 1. Suppose we have a uniform grid with a step Δ, the values of some function $f_i = f(i\Delta), i = n, n-1, ..., n-m$ are known. Then the predicted value of the function, built on the basis of Newton's interpolation polynomial at the point $(n+1)\Delta$ can be found on the basis of the relation:

$$f_{n+1}^{m} = \sum_{k=1}^{m} (-1)^{k-1} C_m^k f_{n-k+1} \,. \tag{1}$$

Proposition 2. If there is a limit

$$\exists \lim_{m\to\infty} \frac{1}{m} \sum_{k=2}^{m} (-1)^{k-1} C_m^k (f_{n-k+1} - f_{n-k+2}) = 0 \,, \tag{2}$$

than

$$f_{n+1} = \lim_{m\to\infty} \frac{1}{m} \sum_{i=1}^{m} f_{n+1}^{i} \,. \tag{3}$$

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SOME WAYS TO SOLVE UNCERTAINTY IN THE PROBLEMS OF ARTIFICIAL INTELLIGENCE

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Applied problems in artificial intelligence in finding the optimal solution usually require a search for options. A sorting problems are characterized by combinatorial nature/ Therefore, the problems of this class are reduced to combinatorial optimization problems. The argument of the objective function in them are combinatorial configurations of different types. The problems of artificial intelligence include the problems of recognition (images, speech), the problems of clinical diagnosis, comparison of texts on plagiarism, automatic translation of texts from one language to another, classification and more. When solving them, there is a situation of uncertainty associated with incomplete input and current information, with vaguely developed rules for processing and evaluating information. If the optimal solution founding on the simulated objective function, then the uncertainty may be related to the special structure of the set of combinatorial configurations, which is an argument of the objective function [1].

The uncertainty situation associated with incomplete input and current information is addressed in a variety of ways, including the use of self-tuning algorithms. They generate additional current information that affects the prediction of future results.

If the set of combinatorial configurations (objective function argument) consists of subsets of isomorphic combinatorial configurations, then in this case there is uncertainty, which is associated with a special structure of the objective function argument. To get out of this situation, the evaluation of the result is carried out for both one and several objective functions, and is solved by introducing variable criteria in the process of solving the problem. One way to solve the uncertainty is to use subclasses of solvable problems.

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TO BAN OR NOT TO BAN: FIGHTING A TRENCH WAR IN COMMENT SECTIONS

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By now, all major businesses, public figures, news outlets and government officials have soundly established their social media presence and create large volumes of highly engaged content daily. Even though the platforms are nominally responsible for automatic detection of inappropriate engagements, some social media users ("trolls") learned how to circumvent existing moderation procedures and take control of comment sections.

In this paper, we present a decision-theoretic approach to identifying and banning trolls, optimized to keep overall engagement quality high, without applying bans indiscriminately. The system is composed of four components:

- It first collects engagements from a monitored social media channel and creates its quantitative representation ("embedding"), a set of 512-dimensional real vectors, each representing a sentence [1].
- A selection of engagements for most prolific engagers are presented to human judges, who return their judgements ("troll", "not a troll", "can not tell").
- An online (continually refined) logistic regression, which learns human judgements based on engagement embeddings and generalizes judgements to all observed engagements.
- An adaptive decision rule that integrates predictions and confidence scores from logistic regression and human judges, returning a final verdict ("ban", "safe", "wait", "send to human judge").

We describe the trade-offs we faced during the design of the system, handling of uncertainty, derived from the need to infer intent of social media users, and an overall cost function used to calibrate the decision parameters of the system.

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THE DEEP GALERKIN METHOD IN NUMERICAL SOLUTION OF THE PROBLEM OF DYNAMIC CONTROL FOR POLLUTION DISTRIBUTION

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We consider the following differential model for the problem of controlling the spread of contaminants in the surface layers and experimental values of the concentration of pollutants

$$Zu \equiv \frac{\partial u}{\partial t} + Lu \equiv \frac{\partial u}{\partial t} - \sum_{i=1}^{2} \frac{\partial}{\partial x_i}\left(D(x)\frac{\partial u}{\partial x_i}\right) + \sum_{i=1}^{2} V \frac{\partial u}{\partial x_i} = -u_0 \phi(x)\delta(t-0), \quad (1)$$

$$u(x,0) = 0, \quad x \in \Omega, \quad (2)$$

$$\left(-\sum_{i=1}^{2} D(x)\frac{\partial u}{\partial x_i} + Vu \right)\Bigg|_{x\in\Gamma} = k(\Gamma)c_0 q_0(x), \quad t \in [0,T],$$
$$\left(-\sum_{i=1}^{2} D(x)\frac{\partial u}{\partial x_i} + Vu \right)\Bigg|_{x\in\partial\Omega\setminus\Gamma} = 0, \quad t \in [0,T], \quad (3)$$

in (1)-(3): $u(x,t)$ – the concentration of Cs-137 in the point $x = (x_1, x_2) \in \overline{\Omega}$ at the moment t in $Q = \Omega \times (0 \le t \le T)$, $\Omega \subset R^2$ with piecewise smooth boundary $\partial\Omega$, $\phi(x)$ – the function describing the rampart-terrace surface Γ, u_0 – surface contamination, k – conductivity coefficient for surface Γ, $\alpha(\Gamma)$ – the slope of the segment of Γ, q_0 – the flow of water coming from precipitation with a substance concentration c_0, $D(x)$ – the effective diffusion coefficient, described by an integral, limited, continuously differentiated function in $\overline{\Omega}$; V – the speed of directed diffusion movement, $V = const > 0$, operator $Z(u)$ is linear, not symmetric, not positively defined operator in $L_2(Q)$ and

$$H,\ \|u\|_H = \left(\int_Q \left[u_t^2 + \sum_{i=1}^{2} \left(\frac{\partial u}{\partial x_i} \right)^2 \right] dQ \right)^{1/2}.$$

We taken into account that [1]: the normative values of parameters $D(x)$, V are $D = 4{,}7 \cdot 10^{-8}$ and $V = 1{,}0 \cdot 10^{-6}$; the precipitation didn't contain Cs-137 and therefore the conditions (3) became the form [1]:

$$\left(-\sum_{i=1}^{2} D \frac{\partial u}{\partial x_i} + Vu \right)\Bigg|_{x \in \partial\Omega} = 0,\ t \in [0,T]\,. \qquad (4)$$

Many studies suggest approximation of the desired solution by neural networks based on activation functions of different types, but numerical approaches based on modifications of the Galerkin method are the most effective for equations of type (1)-(3).

Therefore, we consider the problem (1), (2), (4) in $\overline{Q}$ and minimize in L_2 the functional error of the form:

$$\Im(\tilde{u},\overline{\theta}) = \left\| Z\tilde{u} - f \right\|^2_{L_2(Q)} + \left\| -\sum_{i=1}^{2} D \frac{\partial \tilde{u}}{\partial x_i} + V\tilde{u} \right\|^2_{L_2(\partial\Omega\times[0,T])} + \left\| \tilde{u}(x,0) \right\|^2_{L_2(\Omega)},$$

$$\tilde{u}(x,t;\theta) = \sum_{i=1}^{H} c_i e^{-\omega_{1i}(x_1 - x_{1i})^2 - \omega_{2i}(x_2 - x_{2i})^2 - \omega_{3i}(t - t_i)^2} \square$$

where H – the number of hidden neurons in the layer, $\overline{\theta}$ – the vector of search parameters of neural networks.

Following the main idea of the Deep Galerkin Method [2], we randomly select points in Q, on the boundary $\partial\Omega\times[0,T]$, at the initial moment $t = 0$. Then calculate $\tilde{u}(x,t;\theta)$ and the functional error at the randomly select points and take a descent step at the randomly select points with the calculation of the gradient of the error functional:

In [2, 3], a set of theorems on the approximation properties of neural networks for quasilinear parabolic differential equations with partial derivatives is considered. These results make it possible to prove that for a class of neural networks with one hidden layer and n hidden neurons that minimize the functional error $\Im(\tilde{u},\theta)$, there is a sequence of neural networks $\tilde{u}^n(x,t;\theta)$ such that $\Im(\tilde{u}^n,\theta) \to 0,\ n \to \infty,$ and $\tilde{u}^n(x,t;\theta) \to \hat{u},\ n \to \infty,$ in L_2 in the approximation sense.

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SOME STOCHASTIC MODELS OF OPTIMAL CONTROL OF CYCLIC PROCESSES

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This work is devoted to the construction of the optimal control strategies for phenomena that has a cyclical nature. The applied stochastic models which describe the situations when some random processes can be reproduced many times under similar conditions are considered [1]. The peculiarity of these models is that it is impossible to use classical approaches to the study of each separate cycle. First of all, the length (τ) of the interval in which the control is carried out is random. In addition, the ergodic properties of these processes are such that all of their states (with the exception of one) are insubstantial.

The approach which analyzes the phenomenon "as a whole" is proposed. A formal stochastic model built using this approach considers all cycles simultaneously. Therefore we can use the methods of process control on an infinite time interval to build of optimal strategies.

Two models are investigated. In first model it is assumed that the consequences of the decisions made will become known after the completion of control over the entire interval of random length τ. The second model is dynamic and allows you to control the outcome of each decision. For these models, the concepts of risk functions and of the corresponding for it control strategies are introduced. Constructive algorithms for calculating the values of risk functions and constructing optimal control strategies using them have been developed.

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CURRENT PROBLEM IN THE DEVELOPMENT OF CYBERNETICS

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The use of modern computer technology (CT) provides information processing. Its is reduced to operations on numbers specified in the binary number system (in bits), and program of the information processing in the computer must be represented by binary codes. Since the development of CT is closely related to the development of its element base, which has long been tracking the miniaturization in the size of equipment and energy consumption, it became possible to significantly increase the computing power of machines. As a consequence of this, the volume of processed information in it began to increase unreasonably, which led to an increase and complication of the program of calculations in units of information bits. In the development of CT arose a contradiction between the huge growth of the computer hardware and the technological information processing in it, which remained the same as it was in the first machines.

The resolution of this contradiction is a problem, on the one hand, in finding information technology in such large units that would correspond to the growth of hardware capabilities, and on the other hand, in the search for computational schemes to support this technology. In other words, there is a desire to be able to process even larger volumes of information, and then the problem under consideration is incomparably aggravated in computer engineering.

Analysis shows that the necessary knowledge is lacking in cybernetics to solve this problem, and it should be sought in disciplines such as physics and mathematics. In particular, in mathematics, the branch of algebras is promising in this regard. There are algebras, for example, the algebra of polynomials, in which the elements (polynomials) are capable of carrying a large amount of information than is contained in a bit of binary arithmetic. And such an element of the algebra of polynomials, it is advisable to use in the internal language of a computer as a unit of information.

OPTIMAL CONTROL PROBLEM WITH THE BOUNDARY FUNCTIONAL FOR A NONLINEAR STATIONARY QUASI OPTICS EQUATION WITH A SPESIAL GRADIENT TERM

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We consider the problem of finding the minimum of functional

$$J_\alpha(v)=\beta_0\left\|\psi(0,.)-y_0\right\|^2_{L_2(0,L)}+\beta_1\left\|\psi(l,.)-y_1\right\|^2_{L_2(0,L)}+\alpha\left\|v-\omega\right\|^2_H \quad (1)$$

on the set of admissible controls

$$V=\left\{v=v(z)=\left(v_0(z),v_1(z)\right):\ v_m\in W_2^1(0,L),\left|v_m(z)\right|\le b_m,\right.$$

$$\left.\left|\frac{dv_m(z)}{dz}\right|\le d_m, k=\overline{1,n}, m=0,1, \overset{0}{\forall} z\in(0,L)\right\},$$

under conditions

$$i\frac{\partial\psi}{\partial z}+\frac{\partial}{\partial x}\left(a_0(x)\frac{\partial\psi}{\partial x}\right)\Delta\psi+ia_1(x,z)\frac{\partial\psi}{\partial x}-a(x)\psi+v_0(z)\psi+iv_1(z)\psi+$$

$$+a_2\left|\psi\right|^2\psi=f(x,z),\ (x,z)\in\Omega, \quad (2)$$

$$\psi(x,0)=\varphi(x),\ x\in(0,l), \quad (3)$$

$$\frac{\partial\psi(0,z)}{\partial x}=\frac{\partial\psi(l,z)}{\partial x}=0, z\in(0,L), \quad (4)$$

where $i=\sqrt{-1}$ imaginary unit, $L>0$, $b_m>0$, $d_m>0$, $m=0,1$, $\alpha\ge0, \beta_0\ge0, \beta_1\ge0, \beta_0+\beta_1\ne0$ are given numbers, $0\le x\le l,\ 0\le z\le L,\ \Omega_z=(0,l)\times(0,z),\ \Omega=\Omega_L$; $\psi=\psi(x,z)$ is wave function; a_2 is given complex number that satisfy the conditions

$$a_2=\operatorname{Re}a_2+i\operatorname{Im}a_2, \operatorname{Im}a_2>0, \operatorname{Re}a_2<0, \operatorname{Im}a_2\ge2\left|\operatorname{Re}a_2\right|; \quad (5)$$

$a_0(x), a(x), a_1(x,z)$ are measurable bounded real-valued functions that satisfy the conditions:

$$0<\mu_0\le a_0(x)\le\mu_1, \left|\frac{da_0(x)}{dx}\right|\le\mu_2,\ \overset{0}{\forall} x\in(0,l),\ \mu_0,\mu_1,\mu_2=const>0; \quad (6)$$

$$0 < \mu_3 \le a(x) \le \mu_4,, \overset{0}{\forall} x \in (0,l), \quad \mu_3, \mu_4 = const > 0, \qquad (7)$$

$$|a_1(x,z)| \le \mu_5, \ \left|\frac{\partial a_1(x,z)}{\partial x}\right| \le \mu_6, \left|\frac{\partial a_1(x,z)}{\partial z}\right| \le \mu_7, \left|\frac{\partial^2 a_1(x,z)}{\partial x \partial z}\right| \le \mu_8, \overset{0}{\forall}(x,z) \in \Omega,$$

$$a_1(0,z) = a_1(l,z) = 0, z \in (0,L), \ \mu_5, \mu_6, \mu_7, \mu_8 = const > 0; \qquad (8)$$

$\varphi(x)$, $f(x,z)$, $y_0(z), y_1(z)$ are given complex-valued functions satisfying the conditions:

$$\varphi \in W_2^2(0,l), \frac{d\varphi(0)}{dx} = \frac{d\varphi(l)}{dx} = 0, \ f \in W_2^{0,1}(\Omega) \ , \ y_0, y_1 \in L_2(0,L) \ ; (9)$$

$\omega \in H$ is a given element, $H \equiv W_2^1(0,L) \times W_2^1(0,L)$ 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 optimalitiy condition in variational inequality form for its solution is obtained [1].

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FEATURES OF THE DESIGN OF COMPUTER SYSTEMS ON THE CRYSTAL OF PLIC

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For programmable logical integrated circuits (PLIC) due to the level of integrated technology (at least 10 million gates on the crystal) and the properties of the PLIT adaptation under the algorithms implemented, the design methods using chip on the board are unacceptable. There is a need to create a new methodology for designing a system on a crystal (System-On-Chip, SoC) and determining its features.

The system on a crystal is a super-high integrated circuit (SHIC) containing various complex functional blocks (CF blocks) on the crystal, which form a complete product for offline use in electronic equipment. CF blocks must be repeated and customizable to solve problems. Re-use of such blocks that are called computational blanks

for their functional and technological adaptability, reduces labor costs and the design of the SoC architecture.

The structure of the CF blocks includes a microprocessor core with peripheral devices in various combinations. The SF blocks have two main forms of representation:

1) in the form of topological fragments for the implementation of the crystal (hardware implemented CF blocks);

2) in the form of models in the language description of equipment (Verilog, VHDL), which can be converted to topological fragments (synthesized CF blocks).

In the process of designing SOC, you can develop the necessary CF blocks yourself, to buy them from leading developers or use SF blocks available in free access. In large firms, which for many years are engaged in the development of SBI, and now SoC, large libraries of standard modules have been developed, the stages of design and modeling the SOC operation and its verification are proposed. On the sites of the manufacturers of structural integral assets of special purpose and CAD tools for them, a variety of computational blanks are represented. As a result, there is a large selection of specialized SF block libraries for various applied areas and microcircuit manufacturing technologies, but there is no information about integrated CAD, which can effectively solve problems of designing systems on a crystal in the entire range of possible ways to implement.

MULTIDIMENSIONAL RENEWAL EQUATION IN NONLINEAR NORMALIZATION

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Let $X^{\varepsilon}(t)$ - a family of Markov processes with continuous time and a finite number of states $1,2,..,n.$ $X^{\varepsilon}(t) \to X(t),$ where $\varepsilon \to 0.$

Suppose $\xi_i^{\varepsilon}(t)$ - process with independent increments, $t \geq 0,$ $\xi_i^{\varepsilon}(t) > 0,$ $i = 1,2,..,n.$

Consider the next process

$$\begin{cases} \xi^{\varepsilon}_{i(1)}(t), & when \quad t<\tau, \quad X^{\varepsilon}(0)=i, \\ \xi^{\varepsilon}_{i(1)}(\tau)+\xi^{\varepsilon}_{j(2)}(t-\tau), & when \quad \tau \le t<\tau_1 \quad X^{\varepsilon}(\tau)=j, \\ \xi^{\varepsilon}_{i(1)}(\tau)+\xi^{\varepsilon}_{j(2)}(t-\tau)+\xi^{\varepsilon}_{s(3)}(t-\tau_1), & when \quad \tau_1 \le t<\tau_2 \quad X^{\varepsilon}(\tau_2)=s, \\ \qquad\qquad ..... \end{cases}$$

For this process, the multidimensional renewal equation has the next representation

$$E_i(e^{-\lambda\varsigma^{\varepsilon}(t)}) = E_i(e^{-\lambda\xi^{\varepsilon}_i(t)}) \cdot P\{\tau < t \mid X^{\varepsilon}(0)=i\} +$$

$$+\sum_{j=1}^{m}\int_0^t (E_i(e^{-\lambda\varsigma^{\varepsilon}(u)}))\, p_{ij}(du) \cdot E_j(e^{-\lambda\varsigma^{\varepsilon}(t-u)}).$$

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FINDING THEORETICAL FUNCTIONS OF DISTRIBUTION FOR A LARGE SAMPLE

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We know that

$n_i^j = \sum_{s=1}^{n_i^j} p_{ij}^s$ – the number of average elements of the sample

$$x_1^j(i), \ldots, x_{n_j}^j .$$

Then $n_i^j \to \sum_{s=1}^{\infty} p_{ij}^s \to \infty$ with $N \to \infty$. Consider $x_1, \ldots, x_N$ – large sample. Then

$$F \downarrow i \uparrow N(x) = \left(\uparrow N(x)\right)\Big/ N .$$

According to Kolmogorov's criterion, let there be theoretical distribution functions for the general population

$$x_1^j(i), \ldots, x_{n^j}^j(i),$$

where j= 1,…,m, and they will be accordingly $F_i^j(x)$.

Then we claim that $F_i(x) = \sum p_j F_i^j(x)$ is, according to Kolmogorov's criterion, a theoretical function of the distribution of the total population $x_1, \ldots, x_N$.

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APPLICATION OF THE AVERAGING METHOD TO THE LINEAR BY CONTROL OPTIMAL CONTROL PROBLEM FOR THE SYSTEM OF DIFFERENTIAL INCLUSIONS WITH FAST PARAMETERS

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We consider the optimal control problem for the system of differential inclusions with fast oscillating parameters on finite interval. Similarly to [1] we apply the averaging method investigated in [2,3], according to that fast oscillating parameters are replaced by averaged. We use results from [4] about close relationship of the original and averaged problem, namely the known analogue of the first Bogolyubov theorem. Considering the controls of the original problem and the averaged problem to be linear and belonging to the same set, without the condition of asymptotic constancy, we prove the convergence of optimal controls and optimal trajectories of original problems to optimal controls and trajectories of averaged problems. Also we show that the optimal control of the averaged problem is asymptotically optimal for the original problem that is the minimum of the quality criterion is realized with accuracy small parameter.

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MATHEMATICAL MODELING OF ONE-DIMENSIONAL NON-STATIONARY STRESS-STRAINED STATE OF SOIL MASSIF WITH FREE SURFACE UNDER HEAT AND MASS TRANSFER

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The mathematical model of the one-dimensional problem of stress-strain state of soil massif with free surface under heat and mass transfer in it in general accepted notation can be described as the next boundary value problem (1)-(4) [1]:

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:

$$\left(\lambda_i(c,T_i)+2\mu_i(c,T_i)\right)\frac{\partial^2 U_i}{\partial x^2}+\frac{\partial\left(\lambda_i(c,T_i)+2\mu_i(c,T_i)\right)}{\partial x}\frac{\partial U_i}{\partial x}-\left(\frac{\partial\left(\lambda_i(c,T_i)+2\mu_i(c,T_i)\right)}{\partial x}T_i+\right.$$
$$\left.+\left(\lambda_i(c,T_i)+2\mu_i(c,T_i)\right)\frac{\partial T_i}{\partial x}\right)\alpha_T^{(i)}+X_i=\frac{\partial^2 U_i}{\partial t^2},\ i=1,2,\ \ x\in(0,l),\ t>0, \tag{1}$$

the equation of convective diffusion in the presence of heat and mass transfer for the water-saturated area of the soil massif

$$\frac{\partial}{\partial x}\left(D(c,T_1)\frac{\partial c}{\partial x}\right)-\upsilon\frac{\partial c}{\partial x}-\gamma(c-C_m)+\frac{\partial}{\partial x}\left(D_T\frac{\partial T_1}{\partial x}\right)=n_p\frac{\partial c}{\partial t},\ \ x\in(0;\,l_1),\,t>0, \tag{2}$$

the convective heat transfer equation in both areas of the soil massif

$$\frac{\partial}{\partial x}\left(\lambda_T^{(i)}\frac{\partial T_i}{\partial x}\right)-\rho c_\rho\bar{\upsilon}\frac{\partial T_i}{\partial x}=c_T^{(i)}\frac{\partial T_i}{\partial t},\ i=1,2,\ \ x\in(0,\,l),\ t>0, \tag{3}$$

the strain and stress are calculated by the formulas

$$\varepsilon_i=\frac{\partial U_i}{\partial x},\ \ \sigma_i=\left(\lambda_i(c,T_i)+\mu_i(c,T_i)\right)\left(\varepsilon_i-\alpha_T^{(i)}\bar{T}_i\right),\ i=1,2,\ \ x\in(0,l),\ t>0 \tag{4}$$

and with appropriate boundary conditions on the boundaries of the soil massif and the conditions for conjugation of the ideal contact for displacements, temperature, as well as the boundary conditions for the

piezometric pressure and the concentration of salts on the boundaries of the water-saturated soils.

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APPLICATION OF MULTICRITERIAL DECISION-MAKING METHOD FOR CLASSIFICATION SUITABLE SITES FOR ORGANIC AGRICULTURE

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Mathematical models of heat- , mass- and moisture transfer problems in porous media make it possible to investigate the influence of man-made factors and build the effective strategies for soil massifs useful use[1]. However, geographic information systems (GIS) allows us to collect additional data on environmental, agrochemical, geographical, socio-economic condition of land, which leads to the emergence of a new class of tasks.

The problem of multicriteria decision-making method application for the purpose of classification and ranking suitable sites for organic farming is solved. This problem is solved using the Analytic Hierarchy Process method (AHP). Criteria are formed on the basis of a large array of diverse information. The main criteria in the GIS system database include data on soil contamination by radionuclides and other pollutants, location of pollution sources, agrochemical analysis, landscape, relief, groundwater hydrology, hydrography, road transport system and infrastructure [2]. An appropriate hierarchy is built and priorities are set among the elements of the hierarchy. The experts assessed the hierarchy through a series of comparisons. Priorities related to the nodes of the MAI hierarchy have been identified and established, the consistency of judgments has been checked and the final decision based on the results of the process has been obtained.

The corresponding algorithm is implemented on Python programming language using the free cross-platform geographic information system QGIS. The results of the algorithm will be

implemented into the information-analytical system of organic farming and ensuring environmental sustainability of soils.

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