

*Taras Shevchenko National University of Kyiv
(Faculty of Cybernetics)
University of Defence, Brno, Czech Republic
International Institute for Applied Systems Analysis
(Austria),
Glushkov Institute of Cybernetics of NAS of Ukraine
System Analysis Committee of Presidium National
Academy of Sciences of Ukraine
Academy of Sciences "Vyshcha Shkola" of Ukraine
Noosphere Ventures Corporation
Brno Local Chapter of Union of Czech Mathematicians
and Physicists*

***XXIV International Conference
PROBLEMS OF DECISION
MAKING UNDER
UNCERTAINTIES
(PDMU-2014)
September 1-5, 2014***

***ABSTRACTS
Series B***

Cesky Rudolec, Czech Republic

**Київ
2014**

УДК 007 (100)(06)

ББК 32.81я43

Надруковано за рішенням Вченої Ради факультету кібернетики Київського національного університету імені Тараса Шевченка (протокол № 9 від 16 червня 2014р.)

INTERNATIONAL PROGRAM COMMITTEE

Nakonechny (Ukraine) - Chairman

***M.Bratiychuk (Poland), Yu.Ermoliev (Austria),
I.Gaishun (Belarus), I.Herlin (France), J.Kaluski
(Poland), V.Korolyuk (Ukraine), A.Lindquist
(Sweden), J.Michalek (Czech Republik), I.Sergienko
(Ukraine), Yu.Shestopalov (Sweden), R. Viertl
(Austria), O.Zakusylo (Ukraine)***

NATIONAL ORGANIZING COMMITTEE

A.Anisimov – Chairman

V. Holcner – Chairman

***M.Bartish, I.Beyko, O.Iksanov, Ya.Chabanyuk,
V.Donchenko, F.Garashchenko, P.Knopov, I.Kharin,
E.Lebedev, V.Marcenyuk, M.Sedlačik, N.Semenova,
S.Shakhno, F.Sopronyuk, A.Vlasyuk, Ya.Yeleyko,
V.Zaslavsky, S. Zhuk***

LOCAL ORGANIZING COMMITTEE

P.Zinko – Chairman

O.Lukovych, O.Kapustian,

M.Loseva, T.Korobko,

O.Pavluchenko, T.Zinko,

L.Doudová, D.Hampel,

J.Odehnal, M.Fusek

ISBN 978-966-8725-10-4

CONTENT¹

ЗМІСТ

Andrushchak I.Ye., Marcenyuk V.P., Marcenyuk O.M. Mathematical tools for decision support system of medical system research under uncertainties	11
Bakhrushin A.V., Bakhrushin V.E. Multi-dimensional assessment of complex systems and its realization using R	13
Bartish M., Venherskyi P. Investigation stability and convergence interval iteration methods in kinematic wave problem.....	14
Bartish M.Ya., Kovalchuk O.V. Three-Step method with memory based on finite-difference Newton's method for solving system of nonlinear equations.....	15
Beridze Z., Geladze N. Elaboration of Dialogue Procedures in Safety Support Automated Systems of Wireless Networks.....	16
Beyko I. Optimized modeling and realizable simulators	16
Beyko I., Pidvalna J., Poltoratskyj M. Numerical algorithm for time differential game with incomplete data	17
Beyko I., Shchyrba V. Suboptimal controls in uncertain environment.....	18
Beyko I., Zinko P. Optimized simulators and algorithms of risk minimization.....	19
Bondarchuk. Y.V. Version of the dss abstraction.....	20
Bondarenko V. The power approximation of the time series	22
Bovsunivskyi O. Decision making problem with fuzzy set of preference relations	24
Bratiychuk M. Gerber-Shiu discounted penalty function optimization problem for risk model with multiple thresholds	25

¹ The abstracts are publishing in authors edition
Тези друкуються в авторській редакції

Chechelnitski A., Kucherenko O. On properties of one network models with dependent input flows	26
Chechelnitska K. Mix network of queue with parallel structure and bivariate poisson input flows	27
Cherniy D. On F partial solutions of the Navier-Stokes.....	29
Correll Raymond Consequences – an often forgotten part of risk	31
Didmanidze I., Zoidze N., Zoidze K. Technical and programming supportive means of foreign language learning.....	31
Didmanidze I., KakhianiG., Didmanidze D. Multilayer neural network	32
Dolenko G., Lobach S. Application of approach to decision making in counter terrorism activity.....	34
Donadze M., Imnaishvili G., Sirabidze N. On one of the Algorithms for Optimizing Calculation Processes in the Local Network	34
Donchenko V., Zinko T. Hough - pairs of spaces in a characters recognition problem.....	36
Donchenko V. Generelizing of artificial neuro nets	38
Frank J., Zhuk S. Mobius integrators for control problems	40
Garkusha N. Study of a model of environmental "Predator-Prey" without age structure	40
Golichenko I.I. Filtering problem for periodically correlated stochastic processes.....	41
Gorun P. P., Chabanyuk Ya. M. Application of stochastic optimization procedure to investment portfolio problem	42
Gritsenko V., Timashova L. Methods of intelligent modeling of economic and manufacturing processes for managerial decision support systems	44
Gryshchenko O., Zagorodnia G., Onotskyi V. Numerical simulation of the process of optical radiation in the deforming medium	46

Holešovský J., Michálek J. Estimation of extreme values: a case study for the intensity-duration-frequency curves assessment.....	47
Iemets O., Yemets O. Uncertain linear systems of inequalities: strong solvability and strong feasibility	48
Ivokhin E., Adzhubey L., Almodars Barrak Subhi Kaml One algorithm for the two-level model of production and transportation problem solving.....	49
Kakoychenko A. On analysis of futures markets by Monte Carlo method	50
Kaluski J. The classical and quantum decision making logic	50
Kapustyan O.V., Kapustian O.A., Rusina A.V. Approximate synthesis in impulse distributed optimal control problem with rapidly oscillating coefficients	52
Kasyanyuk V.S. Information operator and optimal algorithms in problems of measurement and detection	53
Kasyanyuk V., Malutenko L. Data clustering using theoretic-possibility approach.....	54
Khytryi I.V. A decision tree building using rank statistics	55
Kinash A.V., Chabanyuk Ya.M., Khimka U.T. Asymptotic dissipativity of the random evolution with impulse perturbation.....	56
Kindyaliuk A.A., Prytula M.M. The new inverse burgers dynamical system and its integral submanifold	57
Kolyada Yu.E., Bulanchuk O.N. Nonstationary temperature fields in mediums with the dynamic characteristics.....	58
Kosarevych K.V. Probabilistic approach to construction of models of duopoly with quadratic functions of costs of producers.....	60
Kukurba V., Chabanyuk Ya., Malanchuk O. Asymptotic generator of optimization procedure with impulsive perturbations	61
Kushnir I., Yeleyko Ya. Markov model health insurance polices.....	62

Lebedev E., Ponomarov V. Steady state analysis of infinite retrial queues	62
Losieva M., Pryshliak D. Topology of hamiltonian vector fields on closed domain	63
Luz M.M., Moklyachuk M.P. Minimax filtering problem for stochastic sequences with stationary increments	64
Maksyshko N., Shapovalova V. Modeling of fundamental factors on the dynamics of prices for real property under uncertainty	65
Manovytska D. Application of the Agent-Based modeling approach to decision making	66
Marcenyuk V.P., Maihruk Z.V. Investigation of nonlinear dynamics in model of hodgkin-huxley based on lyapunov's exponent.....	67
Marin D.E. About one algorithm clustering databases in electronic commerce.....	69
Marcenyuk V., Kuchvara O. Software environment of epidemiological system research	70
Mashchenko S.O., Al-Sammarraie Mohammed Saad Ibrahim A mathematical programming problem with the fuzzy set of constraints	71
Nakonechniy O., Kotsur M., Kapustian O. To the issue of solution estimating of linear variational equations in Gilbert spaces under uncertainties.....	72
Nakonechniy O., Demydenko S. Linear estimates of the stochastic processes mean values under uncertainties.....	73
Norkin B. Risk management and decision support in insurance	74
Pampuha I., Savkov P., Savkova V. The mathematical model of formation an administrative decisions of providing an educational services in educational institutions.....	75
Pashko A.A. Simulations of fractional brownian motion	76

Petlenko Y.V. The use of the def model in estimating the cost of equity capital in vertically integrated company.....	77
Platsydem M., Sheremeta M., Kinash O. Estimates for the maximus modulus of analytic characteristic functions	78
Podlipenko Yu. K. Guaranteed estimates of solutions and right-hand sides of infinite systems of linear algebraic equations under uncertain data	80
Pryshchepa O. The threshold control policy for retrial queues with two retrial attempts.....	81
Rozora I., Lukovych O. Calibrated mean in sampling survey	82
Savkova V., Gómez J. The grounding for indicators of quality of education in HEI (Higher Educational Institutionals)	84
Semenova N.V., Lebedeva T.T., Sergienko T.I. Properties of the perturbed cones in vector optimization problem	85
Shakhno S.M., Yarmola H.P. Semilocal convergence analysis of combined methods	86
Shatashvili A., Bakuridze M., Didmanidze M. On conjugate trigonometric series	87
Shchestyuk N. Minimax estimating for the volatility surface.....	88
Shkilniak O.S. Transitional modal logics of non-monotone partial predicates.....	90
Shkilniak S.S. Logics of partial and multi-valued predicates with extended renominations.....	91
Shpak P., Yeleyko Y. Semi-continuous killed Markov decision processes.....	92
Sirenko I., Stelia I. Environmental information systems engineering experience.....	93
Skachko D.O., Skachko I.O. Decision support information technology in portfolio management based on forecast methods	94

Skarga-Bandurova I. Aggregation approach in group decision making	97
Slabospitsky A.S. Recurrent least squares non-stationary parameter estimation with least deviation norm from 'attraction' points for systems under uncertainties.....	98
Slavko B.V. Comparative analysis of traffic control methods.....	99
Stefanyshyna-Gavryliuk Y.D., Stefanyshyn D.V. Practical presentations of risk function in applied problems of decision-making.....	100
Stelia O., Tsukanova D. Computer modeling for the solution of environmental problems	101
Timofeeva N.K. About unclearness and infinite in combinatorial optimization.....	102
Usar I., Protopop I., Makushenko I. Switched system in retrieval queueing	103
Vergunova I.M. Using of templates in algebraic functional networks for simulation of technological processes.....	104
Vlasyuk A.P., Zhukovska N.A. Mathematical modelling of heat and mass transfer effect on the stress-strained state of soil array on the availability of moving free surface and strength of connectivity in two-dimensional statement	105
Vlasyuk A., Drozdovskyi T. Mathematical modeling of soil layer stress-deformed state change under fluid filtration via radial basis function method.....	107
Vlasyuk A., Tsvetkova T. Mathematical modeling of salt transfer process under simultaneous filtration and moisture transfer in saturated and non-saturated soils with vertical drainage.....	108
Vlasyuk A.P., Zhukovskyy V.V. Mathematical modelling of vertical migration of radionuclides in unsaturated porous media in non-isothermal conditions one-dimensional case	110
Voloshchuk S.D. Mathematical modeling dynamics value of stocks	112

Zahorodnii Yu., Voytenko V. An approach to modeling of decision making systems for mobile platforms	113
Nakonechnyi O., Zinko P. Best-mean estimates in models of information confrontation.....	114
Алиев С., Базилевич И. Интегральное уравнение для ветвящегося редуцированного процесса с непрерывным временем.....	115
Алієв С.А, Бойчук З.Г. Гіллястий процес з імміграцією в теорії чисел	117
Горбунов О.А., Осадчий Є.О. Трансформерні технології в складі комплексної реабілітації з навчанням ходьби	118
Гребенник И.В., Чёрная О.С. Некоторые свойства циклических перестановок как вершин перестановочного многогранника	119
Гребенник И.В., Иванов В.Г., Урняева И.А. Математическая модель задачи передачи данных по сети от нескольких источников потребителю.....	120
Гребенник И.В., Ребезюк Л.Н., Ребезюк Е.Л. Особенности математического моделирования задачи одномерного поиска в условиях случайных возмущений.....	121
Джалладова І. А., Бабинюк О. І. Моделювання процесу розвитку демографічних характеристик працездатного населення.....	122
Ємець О.О., Барболіна Т.М. Формалізація взаємного розташування прямокутників з випадковими параметрами.....	124
Ломага М.М., Семенов В.В. Решение выпуклых задач лексикографической оптимизации	125
Мякухін Ю.В. Застосування вдосконаленого математичного методу на базі побудови матриці парних порівнянь, що існує у завданнях оптимального вибору технічних засобів охорони.....	126
Назарага І.М. Застосування матричного методу найменших квадратів для прогнозування обмінних курсів	128

Нікітін А.В., Семенюк С.А., Чабанюк М.Я. Керування з точкою рівноваги функції мети	129
Осадчий Є.О., Горбунов О.А. Трансформерні технології в забезпеченні життєвого циклу пристрою «Exoskeleton»	130
Поляков М.В., Ханін І.Г., Шевченко Г.Я. Опыт разработки и использования Базы знаний в Корпорации «Noosphere Ventures»	131
Романчук К.Г., Стефанишин Д.В. Про надійність системи без надмірності з залежною відмовою	132
Семенова Н.В., Нагорная А.Н. Локализация оценок в многокритериальной задаче на множестве перестановок	133
Тимашов О. Стенди напівнатурного моделювання для створення складних систем.....	135
Чухрай Л., Чухрай В.Є. Мінімаксне оцінювання в гіперболічних рівняннях з розривними коефіцієнтами при неповних спостереженнях	136
Шушарін Ю.В., Салімова Н.А. Рівняння Белмана в задачах оптимізації множин початкових значень для стохастичних різницевих рівнянь з марковськими коефіцієнтами.....	138

MATHEMATICAL TOOLS FOR DECISION SUPPORT SYSTEM OF MEDICAL SYSTEM RESEARCH UNDER UNCERTAINTIES

I.Ye.Andrushchak*, V.P.Marcenyuk, O.M.Marcenyuk****

***Lutsk National Technical University, Ukraine,**

****Ternopil State Medical University, Ukraine**

westa@land.ru, marceniuk@yahoo.com

Here we would like to present our results in field of application of system analysis methods to problem of clinical medicine. We emphasize effects of uncertainty that should be taken into account in such complex systems. It will be shown that even considering deterministic models of such nonlinear systems we see different qualitative behavior closely dealt with parameters values. Let's start from origin of such a problem. Nowadays there are obtained a lot of models describing physiological indices of human body at different diseases and treatment schemes. Primarily they are based on regression analysis. More complex ones use neural networks and evolutionary programming. The most significant attempts to construct mathematical models at different levels of hierarchy of human organism were made by John Murray [3], Keener and Sneyd [2], G.I.Marchuk [1], Mackey and Glass (they investigated nonlinear phenomena applying dynamic systems and introduced notion of dynamic diseases). Without considering uncertainty all these models can be applied for patients from determined groups (primarily for given age and a lot of another restrictions).

As for projects stimulating given research we would like to note the following. During the last years Medical Informatics Department is fulfilling investigations initiated by Healthcare Ministry of the Ukraine in order to develop and use general system analysis algorithm to study different diseases [4] - [9]. Namely, in fields of oncology (melanoma, leukemia), infectious diseases (flue), therapy (bone tissue diseases). Naturally there arises a problem to develop a general model for disease. It is incorrect to state that we managed offering unique universal algorithm to construct disease general model at whole. More correct is to say this approach can be used for diseases of different nature. We believe this approach can be extended to processes in sociology and demography as well as for economy and finance branches tasks. A lot of them have the same nature as human diseases. Let's pay attention on special medical terminology necessary (as small as possible). First of all, the most recognized definition of disease states that disease is a set

of pathologic processes weakening vitality and activity of a human organism. Here pathologic process is a set of pathologic (that is not normal) and protectoral reactions within human organism. That is, the most significant is modeling pathologic process.

Based on this reasoning we offered general model for pathologic process including three counterparts

(i) the *reason* or cause of disease (it may be some external factor (like bacteria, chemicals) or own modified cells (tumor cells);

(ii) *immune system* supports organism with help of specific antibodies (sort of predators) and plasmatic cells (their ancastors);

(iii) *normal cells*, tissues and organs (it is necessary to consider them to satisfy to some constraints of toxicity).

For these researches we used our own software - Software Environment for Medical System Researches (SEMSR). There is developed conceptual model of software environment of system medical investigations support. Implementing it there is offered model of data structure in branch of system medical investigations and invented in terms of XML- technology. There is developed interface which is Web-integrated, user-oriented and adjustable. There are implemented mathematical methods of system analysis of pathologic processes in form of Java-classes hierarchy. There are developed software tools to execute system medical investigations, to prepare results obtained for presentation in Internet and visualization.

References

1. Mathematical modelling in immunology and medicine. - Proc. of the IFIP TC-7 Working Conf., Moscow, USSR, 5-11 July 1982, Ed. by G.I.Marchuk, L.N.Belykh. Amsterdam, New York, Oxford: North-Holland, 1983.
2. Keener, J., Sneyd, J. Mathematical Physiology. New York: Springer Verlag, 1998.
3. Murray J.M. Mathematical Biology. New York: Springer-Verlag, 1989.
4. A. G. Nakonechnyi, V. P. Martsenyuk, Controllability Problems for Differential Gompertzian Dynamic Equations, Cybernetics and Systems Analysis 40 (2): P. 252-259, 2004.

MULTI-DIMENSIONAL ASSESSMENT OF COMPLEX SYSTEMS AND ITS REALIZATION USING R

Bakhrushin A.V., Bakhrushin V.E.

Classic Private University, Zaporizhia, Ukraine

Vladimir.Bakhrushin@gmail.com

Multi-dimensional assessments are widely used when studying complex systems of different nature. They are based on the hypothesis that property which interests us, can not be measured directly, but can be estimated from measurements of a number of other object characteristics. Well-known examples are: university ratings, assessments of applicants at universities, different socio-economic indices (Human development, Press freedom, Consumer price etc.), psychological tests and so on. The main objectives of the assessment may be the ranking of studied objects in magnitude of the integral index or in their deviation from the standard in the attribute space and also object grouping in the equivalence classes corresponded to different levels of the integral index. Methodologies for constructing multidimensional assessments in many areas are very similar.

Usually such assessments are built as weighted sums of partial indicators. But various measures of closeness and similarity as well as different scalarization methods for the integral index formation may also be used depending on the purpose of the measurement and peculiarities of partial indicators.

One of the main problems of multi-dimensional assessments constructing is to ensure their validity, reliability and accuracy. Assessment validity characterizes its ability to measure exactly that quality of an object which interests the researcher. Assessment reliability characterizes its reproducibility in independent repeated measurements of the same objects in the same conditions. Most commonly these characteristics are checked using different types of correlation coefficients. The accuracy of estimates is important from the viewpoint of the possibility to distinguish close objects.

Some of the methods of obtaining multidimensional assessments and ranking of objects were implemented using the programming language R. Among them are methods based on the calculation of the integral index as a weighted sum of the partial indicators, choosing the main indicator and converting of the rest to restrictions, ranking of indicators, maximin and maximax assessment.

INVESTIGATION STABILITY AND CONVERGENCE INTERVAL ITERATION METHODS IN KINEMATIC WAVE PROBLEM

Bartish M., Venherskyi P.

Ivan Franko National University of Lviv, Ukraine

petro.vengersky@gmail.com

We consider the model of shallow water flow in kinematic approximation[1]:

$$\begin{cases} \frac{\partial q_i}{\partial t} + \sum_{j=1}^2 \frac{\partial}{\partial x_j} \left(q_i \frac{q_j}{h} \right) + \frac{h}{Fr^2} \frac{\partial h}{\partial x_i} - \frac{1}{\rho Re} \sum_{j=1}^2 \frac{\partial (\tau_{ij} h)}{\partial x_j} = \\ = K_w \left(\frac{V_\infty^2 |q| q_i}{L Re C^2 h^3 \beta_i} - 1 \right), \quad i = 1, 2, \\ \frac{\partial h}{\partial t} + \sum_{j=1}^2 \frac{\partial q_j}{\partial x_j} = R. \end{cases}$$

Simplified equations of shallow water flow in the form of kinematic wave equation take this form:

$$\begin{cases} \frac{\partial h}{\partial t} + \sum_{j=1}^2 \frac{\partial q_j}{\partial x_j} = R, \\ q_i = \alpha_i h^m, i = 1, 2 \in \Omega \times (0, T], \end{cases}$$

where

$$m=3/2, \alpha_i = C \frac{\beta_i}{\sqrt{|\text{grad } \eta|}}, i=1, 2,$$

C – coefficient Chezi, $\eta(x_1, x_2)$ – function of the relief surface runoff.

The variation problem which was solved by the finite-elements method is formulated. The result is a system of nonlinear equations which were solved by interval iterative methods. We investigated the conditions of stability and convergence of these methods.

References

1. Venherskyi P.S. Matematical model channel flow in kinematic approximation./Venherskyi P.S., Kokovska Y.V.//“DSMSI-2011”: International Conference: Theses of conference reports. May 27-29. – Kyiv, 2011. – P.250-251 .

THREE-STEP METHOD WITH MEMORY BASED ON FINITE-DIFFERENCE NEWTON'S METHOD FOR SOLVING SYSTEM OF NONLINEAR EQUATIONS

Bartish M.Ya., Kovalchuk O.V.

Ivan Franko National University of Lviv, Ukraine

olyak2005@gmail.com

Consider the system of nonlinear equations

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

The famous method for solving (1) is Newton's method that required exact Jacobian matrix in every step. The finite-difference Newton's method is to use the finite-difference as an approximation of derivatives in Newton's method

$$x_{k+1} = x_k - [Q_k]^{-1} P(x_k), \quad (2)$$

where $(Q_k)_{.j} = \frac{P(x_k + h_k e_j) - P(x_k)}{h_k}, \quad j = 1, \dots, n.$

We propose next three-step method with memory based on method (2)

$$\begin{aligned} x_1 &= x_0 - [Q_0]^{-1} P(x_0), \\ u_k &= x_k - [Q_k]^{-1} P(x_k), \\ v_k &= x_k - [Q_{k-1}]^{-1} P(x_k), \\ x_{k+1} &= \arg \min \|P(u_k + \gamma_k (v_k - u_k))\|, \quad k = 1, 2, \dots \end{aligned} \quad (3)$$

We prove convergence of method (3). Testing of method (3) for many problems shows efficiency comparing with method (2) and three-step method base on (2) with [1]

References

1. M. Bartish, O. Kovalchuk, L. Nykolaichuk Three step iteration method for solving of nonlinear equations// Mathematic and computer modeling, collection science work, ser. fiz-math science, vol. – 1, p. 9-18, 2008 (in Ukrainian)

ELABORATION OF DIALOGUE PROCEDURES IN SAFETY SUPPORT AUTOMATED SYSTEMS OF WIRELESS NETWORKS

BeridzeZebur , GeladzeNona

Batumi Shota Rustaveli State University, Georgia

Design of dialogue regimes in which the organization of relationship between customers and system is performed via a dialogue is of great importance in the safety supportive automated systems of wireless networks. In general, errors occurred during automated security will be avoided in case the interface is considered in favour of customers as much as possible.

The initiator of the system dialogue process is a man who sets the working goal and selects means of accomplishment. Meanwhile, the system should provide adequate reaction to the customer needs. Men set the task whereas the system allots the means for the problem solution. Under the dialogue system we generally mean the set of programs which provide relations between men and technical devices. Our aim is to elaborate dialogue algorithm for these relations and determine their contents, on the basis of which programs will be designed afterwards. By means of the dialogue system the dialogue exchange, conversations and procedures should be conducted.

During the functioning of the dialogue system the dialogue exchanges in the automated recogniser system are conducted in succession. While performing certain functions of the dialogue the strictly determined successions are used so that the structure of the exchange successions is fixed. The system dialogue procedure is a part a dialogue system which in the general occasion contains manual operations, human-computer chats and machine procedures.

The article analyses the forms by means of which the elaboration and design of dialogue procedures is conducted in computers.

OPTIMIZED MODELING AND REALIZABLE SIMULATORS

Beyko I.

National Technical University of Ukraine “KPI”, Ukraine

ivan.beyko@gmail.com

New adequate mathematical models and realizable numerical simulators of complex control processes are designed and implemented as sources of new knowledge and new tools of scientific-substantiated decision-making in uncertain environment and uncertain objectives.

Methodology of scientific substantiated decision making covers data mining in search for adequate assess of trends of critical variables required for models optimization to meet practical requirements to the admissible time $T(p)$ and to the admissible error $E(p)$ of results obtained by the models with the alternative values of the model parameters p . In search for optimal values of p that enable obtaining maximal use of available models of different level aggregation and of different resolving power, and as well of all the available sources of useful information, we implement the unified optimality criterion function $J(p)=KT(p)+ E(p)$. The useful information may be obtained from available different heterogeneous information-sources, available knowledge and expert systems that accumulated experience of practitioners and analysts. In search for useful information sources to design optimal working models we develop solve operator methods and algorithms. The proposed methods of models optimization are based on the system decomposition into optimized subsystems in accordance with the unified optimality criterion. The proposed optimization iterative procedures detect those of the model's subsystems that ought to be decomposed and those that ought to be aggregated, taking into account the evaluated $T(p)$ and $E(p)$.

NUMERICAL ALGORITHM FOR TIME DIFFERENTIAL GAME WITH INCOMPLETE DATA

Beyko I., Pidvalna J., Poltoratskyj M.

National Technical University of Ukraine "Kiev Polytechnic Institute"
ivan.beyko@gmail.com

We consider control systems

$$\dot{x}(t) = f(x(t), u(t), q(t), t), \quad t \in [t_0, T], \quad x(t_0) = x^0 \in X^0$$

with unknown functional parameters $q(t) \in Q$. The problem is to find the optimal controls $\bar{u}(t) \in U$ that minimize the functional

$$\forall \tau \in [t_0, t] \quad x(\tau) \in X^0,$$

$$\bar{T}(\bar{u}, \bar{x}, \bar{X}) = \arg \min_{u(t) \in U} t \mid t \geq t_0, \quad x_i(t) = \bar{x}_i(t), \quad i \in I \subset \{1, 2, \dots, n_x\}.$$

In case of $\bar{x}(t)$ being a trajectory $y(t)$ of a control system

$$\frac{dy(t)}{dt} = g(y(t), v(t))$$

the risk extremal control $\bar{\bar{u}}$ is defined by the optimized sets X^0, Y^0 as the time minimizer $\bar{\bar{T}} = \inf_{u(\cdot) \in U} \max_{v(\cdot) \in V} T_{uv}$,

$$T_{uv} = \min \{t \mid \|x_i(t) - y_i(t)\| \leq \varepsilon, i \in I\}.$$

Numerical algorithms for the optimal control calculation implement solutions of the system

$$\begin{aligned} \bar{u}(t) &= \arg \max_{u \in U} (q(t), f(x(t), u)), \quad \dot{x}(t) = f(x(t), u(t), q(t), t), \\ \dot{q}(t) &= -[f'_x(x(t), \bar{u}(t))]^T q(t), \quad x(\bar{T}(\bar{u}, \bar{x}, \bar{X})) = \bar{x}(\bar{T}(\bar{u}, \bar{x}, \bar{X})). \end{aligned}$$

SUBOPTIMAL CONTROLS IN UNSERTAIN ENVIRONMENT

Beyko I., Shchyrba V.

National Technical University of Ukraine “Kiev Polytechnic Institute”

ivan.beyko@gmail.com

We consider complex optimization problems in search for optimal controls $u^0 \in U$ that minimize risk functionals $F_0(x, u, t_0, T, q)$ and satisfy inequalityies $F_i(x, u, t_0, T, q) \leq 0$,

$$\begin{aligned} F_i(x, u, t_0, T, q) &\triangleq \int_{t_0}^T h_i(x(t), u(t), t, q(t)) dt + \\ &+ g_i(t_0, T, x(t_0), x(T), q(t_0), q(T)), \quad i = \overline{0, m} \end{aligned}$$

on trajectories x of control systems

$\dot{x}(t) = f(x(t), u(t), q(t), t)$, $t \in [t_0, T]$, $x(t_0) \in X^0$, $q(t) \in Q$. Optimal values $u^0(t)$ are calculated as minimizers of

$$\max_{q \in Q} \{(\psi^0(t), f(x^0(t), u, q, t)) - \sum_{i=0}^m \lambda_i^0 h_i(x^0(t), u, t, q)\},$$

where $x^0(t), \psi^0(t)$ are a nontrivial solution of the system

$$\dot{x}(t) = f(x(t), \bar{u}^0(t), t, \bar{q}(t)), \quad x(\bar{t}_0) = \bar{x},$$

$$\frac{d\psi(t)}{dt} = -\psi(t) f'_x(x(t), \bar{u}^0(t), t, \bar{q}(t)) + \sum_{i=0}^m \lambda_i h'_{ix}(x(t), \bar{u}^0(t), t),$$

$$\psi(\bar{t}^0) = \sum_{i=0}^m \bar{\lambda}_i^0 g'_{\bar{x}}(\bar{t}_0, \bar{T}, \bar{x}, \bar{x}), \quad \psi(\bar{T}) = \sum_{i=0}^m \bar{\lambda}_i^0 g'_{\bar{x}}(\bar{t}_0, \bar{T}, \bar{x}, \bar{x}), \quad x(\bar{T}) = \bar{x}.$$

$$\bar{t}_0 < \bar{T}, \bar{\lambda}^0 \equiv (\bar{\lambda}_0^0, \bar{\lambda}_1^0, \dots, \bar{\lambda}_m^0) \geq 0, \bar{\lambda} \equiv (\bar{\lambda}_0, \bar{\lambda}_1, \dots, \bar{\lambda}_m) \neq 0.$$

If the risk measure is evaluated by the time value $T - t_0$ under restrictions $\bar{x}(t) \in \bar{X} \subset R^{n_x}$, $t \in [t_0, T]$, then the optimal control is calculated as maximizer

$$\bar{u}(t) = \arg \max_{u \in U} (q(t), f(x(t), u)), \frac{dq(t)}{dt} = -[f'_x(x(t), \bar{u}(t))]^T q(t),$$

$$x(\bar{T}(\bar{u}, \bar{x}, \bar{X})) = \bar{x}(\bar{T}(\bar{u}, \bar{x}, \bar{X})).$$

In case of the function $\bar{x}(t)$ being a trajectory $y(t)$ of a control system

$$\frac{dy(t)}{dt} = g(y(t), v(t)) \text{ the risk extremal control } \bar{u} \text{ is defined by the}$$

optimized sets X^0, Y^0 as the time minimizer $\bar{T} = \min_{u(\cdot) \in U} \max_{v(\cdot) \in V} T_{uv}$,

$$T_{uv} = \min \{t \mid \|x_i(t) - y_i(t)\| \leq \varepsilon, i \in I\}.$$

OPTIMIZED SIMULATORS AND ALGORITHMS OF RISK MINIMIZATION

¹Beyko I., ²Zinko P.

¹National Technical University of Ukraine "Kiev Politechnic Institute"

²Taras Shevchenko National University of Kyiv, Ukraine

ivan.beyko@gmail.com

We consider risk minimization problems in search for the minimizer $u^* = \arg \min_{u \in \Omega} \bar{F}(u)$ of the risk function $\bar{F}(u) = E \max_{q \in Q} \tilde{f}(x(u, q, \theta), u, q, \theta)$ that is defined on the stochastic process $x(u, q, \theta)$ of the graph-operator system

$$A(x, u, q, \theta) \triangleq (A_1(x, u, q, \theta), \dots, A_{N_k}(x, u, q, \theta)) = 0,$$

$$A_k(x, u, q, \theta) \triangleq (A_{k1}(x_{k1}, z_{k1}, u_{k1}, q_{k1}, \theta_{k1}), \dots, A_{kN_{ks}}(x_{kN_{ks}}, z_{kN_{ks}}, u_{kN_{ks}}, q_{kN_{ks}}, \theta_{kN_{ks}})),$$

$$(x, u, q, \theta, z) \triangleq \{(x_k, u_k, q_k, \theta_k, z_k)\}_{k=1}^{N_k}, (x_k, u_k, q_k, \theta_k, z_k) \triangleq \{(x_{ks}, u_{ks}, q_{ks}, \theta_{ks}, z_{ks})\}_{s=1}^{N_{ks}},$$

with control inputs $u \in \Omega$, system parameters $q \in Q$, random values θ of the probability space (Θ, Σ, P) , random performance function $\tilde{f}(x(u, q, \theta), u, q, \theta)$, expected performance indicator $\bar{F}(u)$, and subsystems models $A_{ks}(x_{ks}, z_{ks}, u_{ks}, q_{ks}, \theta_{ks}) = 0$ of the graph's k -th knot that describes interdependences between the ks -th subsystem's states x_{ks} , controls u_{ks} , parameters q_{ks} , random values θ_{ks} , $z_{ks} \triangleq \varphi_{ks}(x, u, q, \theta)$, $k = \overline{1, N_k}$, $s = \overline{1, N_{ks}}$. The high order solve operator algorithms are developed to calculate trajectories $x_{ksi}(t, p, q, \theta)$ of subsystems

$$\begin{aligned} t_0 &= \bar{t}(u_{ks0}, q_{ks0}, \theta_{ks0}, z_{ks0}) \in R, \\ x_{ks0}(t_0) &= \bar{x}_{ks0}(t_0, u_{ks0}, q_{ks0}, \theta_{ks0}, z_{ks0}) \in R^{n_{ks}}, \\ \dot{x}_{ksi}(t) &= a_{ksi}(x_{ksi}(t), u_{ksi}, q_{ksi}, \theta_{ksi}, z_{ksi}, t, \omega_{ksi}(x_{ksi}(t_i), t_i, q_{ksi}, \theta_{ksi}, z_{ksi}, t)), \\ t &\in [t_i, t_{i+1}], \quad t_{i+1} = \tau(x_{ks(i-1)}(t_i), t_i, u_{ksi}, q_{ksi}, \theta_{ksi}, z_{ksi}) > t_i, \\ x_{ks(i+1)}(t_{i+1}) &= \psi(x_{ksi}(t_{i+1}), t_{i+1}, u_{ks(i+1)}, \theta_{ks(i+1)}, z_{ks(i+1)}), \end{aligned}$$

by implementation the high-order simulator

$$\bar{x}(t+h) = p(t+h) + \int_t^{t+h} Q(\tau) (f(p(\tau), \tau) - dp(\tau)/d\tau) d\tau$$

of the trajectory $x(\tau) \triangleq x(\tau, \bar{u}, \bar{q}, \bar{\theta})$ of the control system

$$\dot{x}(\tau) = f(x(\tau), \tau) \triangleq a(x(\tau), \bar{u}, \bar{q}, \bar{\theta}, \tau, \omega(x(t_i), t_i, \bar{u}, \bar{q}, \bar{\theta}, \tau)).$$

We have proved that for any $p(\cdot)$ and $Q(\cdot)$ satisfying asymptotic equalities $p(\tau) = x(\tau) + O(h^l)$, $dQ(\tau)/d\tau = -Q(\tau)A(\tau) + O(h^k)$, $Q(t+h) = I$, the simulator $\bar{x}(t+h)$ satisfy the high-order asymptotic equality $\bar{x}(t+h) = x(t+h) + O(h^s)$, $s=k+l+1$. To calculate u^* we develop numerical algorithms based on stochastic generalized gradient methods and stochastic minimax algorithms.

VERSION OF THE DSS ABSTRACTION

Bondarchuk. Y.V.

Taras Shevchenko National University of Kyiv, Ukraine

byv@univ.kiev.ua

Living of the DSS in the shadow of the decision making (DM) models and methodological knowledge leads to stagnation for most DSS as an independent class of software systems. Independence of the DSS from the methods of DM will remove restrictions of DSS being only a

procedure (a form of) DM method, and a user interface. In [1] presents the authors' opinion on a more adequate paradigm for DSS.

The hierarchy of DSS abstractions (most to least) is the following.

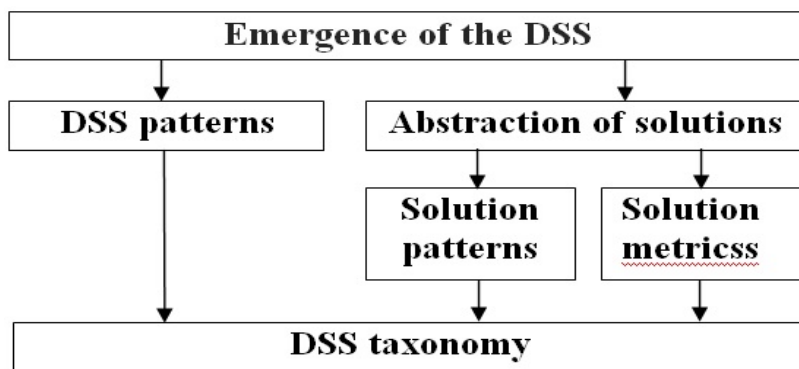
First abstract (maximum): *systemic manifestation* in which the DSS is the interpreter of the set of solutions, with which the decision maker, experts and other decision support system (DSS that is distributed) work. It should be important for the *decision to be a separate object* [1].

2nd abstraction: the manifestation of the DSS structure - DSS patterns

3rd abstraction: the abstraction of decisions - their patterns and metrics.

4th abstract: DSS taxonomy (DSS place among others) (as an option [2]).

Together with DM methods the following composition of abstractions is proposed:



References

1. Бондарчук Ю.В. Щодо модифікації парадигми СППР // Системи підтримки прийняття рішень. Теорія і практика (СППР-2013): Збірник доповідей наук.-практ. конф. –Київ: ПІММС НАНУ, 2013, -с. 9-11.
2. Бондарчук Ю.В. Варіант таксономії СППР //International conference "Problems of decision making under uncertainties" (PDMU-2014). 12-16.5.2014, Mukachevo, p. 68-69.

THE POWER APPROXIMATION OF THE TIME SERIES

Bondarenko V.

National Technical University of Ukraine “Kiev Polytechnic Institute ”
valeria_bondarenko@yahoo.com

We consider a mathematical model for the time series $S_1..S_n$. The primary processing is smoothing, removing the trend-leads to improved time series $x_1..x_n$ - (“initial”).

Consider $x_1, x_2..x_n$ as the observed values of some quantity at some moments of time. Let us choose a random process $X(t)$, where $x_k = X\left(\frac{k}{n}\right)$.

This problem has a controversial solution, because different processes (with different distributions) may have the same trajectories.

The subjective criteria for selection of $X(t)$ is as follows.

1. Process should possess known characteristics, particularly the Gaussian process should be chosen.
2. $X(t)$ should not be Markov, as the Markov communication does not provide an adequate description of real phenomena.

Thus, the proposed approximation leads to the following model of original time series: $x_k = \text{sgn } y_j \cdot |z_j|^\lambda$.

Let's $B_H(t), 0 \leq t \leq 1$ - is fractional Brownian motion with Hurst exponent H , f - is twice differentiable function.

Let's consider the application of algorithm.

As an first example consider the data: the daily data of solar activity (366 data, <ftp://ftp.ngdc.noaa.gov>). We calculated the initial time series $x_1..x_{365}$ with increments $y_k = x_{k+1} - x_k, k = 1, 2..365$.

$$R_{1n} = \frac{1}{365} \sum_{k=1} |y_k| = 0,141; \quad R_{2n} = \frac{1}{365} \sum_{k=1} y_k^2 = 0,04; \quad d = 0,5; \lambda = 1,4.$$

$z_k = \text{sgn } y_k \cdot |y_k|^{0,7}, k = 1..365$. The second example: 1678 values of interest rate (337 data, <http://bank.gov.ua/control/uk/index>). The interest rate is given by the following formula in each time window.

$$S_k = a + b \exp\{X(t)\},$$

$$X(t) = \ln \frac{S(t) - a}{S(0) - a}, \alpha = 0,085,$$

$$x_k = X\left(\frac{k-1}{n}\right) = \ln \frac{S_k - a}{S_1 - a}, x_1 = 0,$$

$$R_{1n} = 0,425; R_{2n} = 0,541; d_n = \frac{R_{1n}^2}{R_{2n}} = 0,334,$$

$$\frac{1}{\sqrt{\pi}} \frac{\Gamma^2\left(\frac{\lambda+1}{2}\right)}{\Gamma\left(\lambda + \frac{1}{2}\right)} = 0,334; \quad \lambda = 2,$$

$$y_k = \operatorname{sgn} y_k |z_k|^2, \quad z_k = \operatorname{sgn} y_k \cdot \sqrt{|y_k|}.$$

Applying the estimation algorithm, we obtain $\hat{H} = 0,3$.

The third example- monthly data interest rate of Germany Bundesbank (www.bundesbank.de) for 2003-2012,120 data.

$$R_{1n} = \frac{1}{119} \sum_{k=1}^{119} |y_k| = 1,39, \quad R_{2n} = \frac{1}{119} \sum_{k=1}^{119} y_k^2 = 3,3, \quad d_n = \frac{R_{1n}^2}{R_{2n}} = 0,59.$$

Applying the method of Hurst parameter estimation, let's calculate the equation

$$\left| \frac{\hat{\sigma}_2}{\hat{\sigma}_1} - 1 \right|, \frac{\hat{\sigma}_2}{\hat{\sigma}_1} = 1,0, \hat{H} = 0,4.$$

References

1. Engle R.F. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation// *Econometrica*. 1982. V.50.№4. P.987-1008.
2. Beran J. *Statistics for Long-Memory Processes* / Beran J. — Chapman and Hall, 1995. — 315 p.
3. Guégan D. *Séries chronologiques non linéaires à temps discret*, Paris, Economica, Série Mathématique et Probabilité, 1994.-301 p.
4. Nelson D.B. Asymptotic Filtering Theory for Multivariate ARCH Models// *Journal of Econometrics*. 1996. V.71. № 1/2 .- P.1-47.
5. *Handbook of Financial Time Series* (Springer, 2009, 1024 pp).

DECISION MAKING PROBLEM WITH FUZZY SET OF PREFERENCE RELATIONS

Bovsunivskiy O.

Taras Shevchenko National University of Kyiv, Ukraine

bovs@email.ua

The report addresses the problem of rational choice of alternatives, provided that the objective of decision maker (DM) is given by the fuzzy set of non-fuzzy preference relations.

It is assumed that the DM can compare any pair of alternatives x, y from the set X by the preference relations: $R_i \subseteq X \times X$, $i \in N = \{1, 2, \dots, n\}$. These relations can be understood as some criteria on which DM compares the alternatives in terms of achieving its objective.

Sometimes the decision maker cannot clearly indicate which of the preference relations R_i , $i \in N$, characterize its objective, but may define some fuzzy subset [1] $\tilde{N} \subseteq N$ of these relations.

The report examines two methods of aggregation of criteria preference relation R_i , $i \in N$, into the aggregate preference relation R : first – aggregation of the union criterion of preference relations $\tilde{R} = \bigcup_{i \in \tilde{N}} R_i$; second – aggregation of their intersection $\tilde{Q} = \bigcap_{i \in \tilde{N}} R_i$. These relations are known as a type-2 fuzzy relation [2] and formalized fuzzy reflection with membership functions, respectively $r(x, y, z)$ and $q(x, y, z)$, $x, y \in X$, $z \in \{0, 1\}$, which act as a "fuzzy membership functions" of these type-2 fuzzy relations.

It is also worth noting that the concept of fuzzy-effective alternatives will be correct for the problem of decision-making with the goal to be specified by the fuzzy set of fuzzy preference relations.

References

1. Mashchenko S., Bovsunivskiy O. Decision making problem with fuzzy set of goal sets // "Information Theories and Applications". – 2012. – 19. – № 3. – P. 249 - 257.
2. Mashchenko S. Fuzzy individual-optimum equilibriums // Cybernetics and computing engineering. – 2010. – № 159. – p. 19 – 29.

GERBER-SHIU DISCOUNTED PENALTY FUNCTION OPTIMIZATION PROBLEM FOR RISK MODEL WITH MULTIPLE THRESHOLDS

Bratiychuk Mykola

Silesian University of Technology, Poland

Mykola.Bratiichuk@polsl.pl

In the report we deal with the classical risk model of the form

$$\xi(t) = u + ct - \sum_{n=1}^{N(t)} \xi_n + \sigma^2 W(t),$$

where $W(t)$ is a standard Brownian motion. Let

$\tau(u) = \inf\{t \geq 0 : \xi(t) < 0\}$ and

$$M(u) = E\{e^{-\delta\tau(u)} U\{\xi(\tau(u)-), \xi(\tau(u))\}, \delta > 0,$$

where $U(x, y)$, $x, y \geq 0$ is a nonnegative bounded function.

The function $M(u)$ is called Gerber-Shui discounted penalty function and it is a powerful analytical tool in risk theory. In the report we consider this function in the following scheme (see, for example [1]). Let n levels $0 = b_0 < b_1 < \dots < b_n < \infty$ be given. We suppose that the premium rate c is equal to c_i whenever $\xi(t) \in [b_{i-1}, b_i)$. The traditional method of finding the function $M(u)$ uses the differentiability of this function which is not obvious. We propose a new approach that enables us not only to overcome the difficulties connected with differentiability of the function $M(u)$ but to find the effective computational algorithm of its finding. Some optimization problem for model in question we have considered as well.

References

1. Lin, X.S., Sendova, K.P., The compound Poisson risk model with multiple thresholds. Insurance: Mathematics and Economics 42, 2008, p. 617--627.

ON PROPERTIES OF ONE NETWORK MODELS WITH DEPENDENT INPUT FLOWS

Chechelnitski A., Kucherenko O.

Taras Shevchenko National University of Kyiv, Ukraine

che@unicyb.kiev.ua

We will consider two systems of the type $[GI/M/\infty]$ with a bivariate input flow customers $(v_1(t), v_2(t))$ where $v(t) = y_1(t) + y_3(t), v_2(t) = y_2(t) + y_3(t)$, and $y_i(t), i = 1, 2, 3$ are independent revival flows.

We will suppose, that the parameters of the model depend from n (number of series) and next conditions are true:

a) $[M\tau_k^i]^{-1} = \lambda_i \neq 0, \beta_i = D\tau_k^i < \infty$, τ_k^i is an interval of the k -th revival, $i = 1, 2, 3$.

b) $\mu_i^{(n)} = \mu_i / n + o(1/n), i = 1, 2$, μ_i is a rate of the time of service in our systems.

For sequence of processes

$$\xi_n(t) = (\xi_n^1(t), \xi_n^2(t)), \quad n \geq 1, \quad t \in [0, T],$$

$$\xi_n^1 = n^{-1/2} (X_i^{(n)}(nt) - \lambda_i n), \quad i = 1, 2$$

($X_i^{(n)}$ is a number of customers in i -th system), where

$\alpha_1 = (\lambda_1 + \lambda_3) / \mu_1, \alpha_2 = (\lambda_2 + \lambda_3) / \mu_2$, the following theorem is true.

Theorem. The sequence of stochastic processes $\xi_n(t)$ converges in uniform metric to diffusion process with infinitesimal mean $a(x) = (a_1(x), a_2(x))$ and diffusion matrix B , where

$$(a_1(x), a_2(x)) = (-\mu_1 x, -\mu_2 x)$$

$$B = \begin{pmatrix} \lambda_1 + \lambda_3 + \beta_1 \lambda_1^3 + \beta_3 \lambda_3^3 & \beta_3 \lambda_3^3 \\ \beta_3 \lambda_3^3 & \lambda_2 + \lambda_3 + \beta_2 \lambda_2^3 + \beta_3 \lambda_3^3 \end{pmatrix}$$

References

1. Griffiths R.S. and Milne R.K. (1978) A class of bivariate Poisson process. I. Multivar. Anal. 8, P.380-396.
2. Chechelnitski A.A., (1999) Asymptotical properties of Erlang Queueing systems with dependent Poisson input flow. Top, v.7, P.221-229.

MIX NETWORK OF QUEUE WITH PARALLEL STRUCTURE AND BIVARIATE POISSON INPUT FLOWS

Kateryna Chechelnytska

Taras Shevchenko National University of Kyiv, Ukraine

kchechelnytska@gmail.com

Today's computer systems are more complex, more rapidly evolving, and more essential to the conduct of business than those of even a few years ago. The result is an increasing need for tools and techniques that assist in understanding the behavior of these systems. We consider a mix stochastic network of the Jackson's type . Our network of queues is a collection of service centers (nodes) $E_0, E_1, \dots, E_r$, which represent multichannel systems. The node E_0 operates as a queuing system of the type $M / M / \infty$, thus the service time of the each customer is exponentially distributed with the parameter $\mu > 0$. The nodes $E_1, E_2, \dots, E_r$ operate as Jackson's network of the type $[M / G / \infty]^r$.

Denote $G_i(t)$ the distribution function of service time in the node E_i ,

$i = 1, \dots, r$. Let us consider a set of the bivariate Poisson input flows

$(\nu_1^i(t), \nu_2^i(t)) \quad i = 1, \dots, r$ with the parameters $\lambda_i = \theta p_i, i = 0, r$; b_i ,

$i = 1, r$; $\sum_{i=1}^r p_i = 1$. In this case our model describe the situation, when

two customers simultaneously arrive in the network.. One customer arrives in the node E_0 ($M / M / +\infty$), another arrive in the one of the nodes $E_1, E_2, \dots, E_r$ of the network $[M / G / \infty]^r$. After a customer is served by the node E_0 it leave the system. Similarly, after a customer is served by one of the nodes $E_1, E_2, \dots, E_r$, it may reenter the same node, move to another one, or leave the network.

Suppose as well that $X_i(t)$, $i = 0, 1, \dots, r$ is a number of customers in the node E_i , $i = 0, 1, \dots, r$ at the time t , $P = \|p_{ij}\|_{i,j=1}^r$ is a transition matrix of the network $[M / G / \infty]^r$, $X(t) = (X_0(t), X_1(t), \dots, X_r(t))$.

Let's consider the generation function of a number of the customers in the network's nodes at the time t :

$$\Psi(z, t) = \sum_{k_0, k_1, \dots, k_r} z_0^{k_0} z_1^{k_1} \dots z_r^{k_r} \times P\{X(t) = (k_0, k_1, \dots, k_r)\}.$$

The next theorem is true.

Theorem 1. Let the queuing network meets following conditions:

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

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

where $z = (z_1, \dots, z_r)$, $a = (a_1, \dots, a_r)$. $D(a) = \|a_i \delta_{ij}\|_{i,j=1}^r$ - diagonal matrix, δ_{ij} is Cronecer symbol, $P^*(\mu) = (I - Q^*(\mu))^{-1} D\left(\vec{G}^*(\mu)\right) \frac{1}{2}$,

$Q^*(\mu) = \int_0^{+\infty} e^{-\mu u} dQ(u)$ is Laplas transform of the semimarkov matrix

$Q(t) = \|q_{ij}(t)\|_{i,j=1}^r$, $q_{ij}(t) = p_{ij} G_i(t)$, $\vec{G}(\mu)$ is Laplas transform of the vector $(1 - G_1(t), \dots, G_r(t))$ in the point μ , $\alpha^{(1)}$ is the solution of the equation $\alpha^{(1)}(I - P) = \lambda$ and $\alpha^{(2)}$ is the solution of the equation $\alpha^{(2)}(I - P) = b$, $b = (b_1, \dots, b_r)$

Consequence. In special case, when $r = 1$ and $G(t) = 1 - e^{-at}$, $t \geq 0$ we can obtain a stationary result for two systems $M / M / \infty$ with bivariate Poisson input flow. The limit distribution has a generation function of the following form

$$\Psi(z_0, z_1) = \exp \left\{ \left(\frac{\lambda_0}{\mu} + b_1 \frac{a}{\mu(\mu + a)} \right) (1 - z_0) - \right. \\ \left. - \left(\frac{\lambda_1}{a} + b_1 \frac{\mu}{a(\mu + a)} \right) (1 - z_1) - \frac{b_1}{\mu + a} (1 - z_0 z_1) \right\}.$$

ON F PARTIAL SOLUTIONS OF THE NAVIER-STOKES

Cherniy D.

Taras Shevchenko National University of Kyiv, Ukraine

D_Cherniy@ukr.net

The three-layered viscous incompressible fluid flow inside narrow layer of height h was considered (*see fig.1*). The main equations described this flow is Navier-Stokes equation

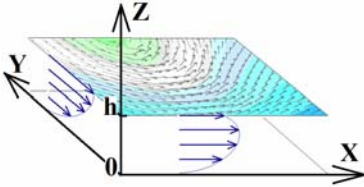


Fig.1.

The three-layered viscous incompressible fluid flow

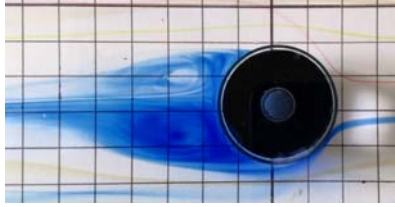


Fig.2.

$$\frac{\partial \vec{V}}{\partial t} + (\vec{V} \nabla) \vec{V} = -\frac{\nabla p}{\rho} + \vec{F} + \frac{\mu}{\rho} \Delta \vec{V} \quad (1)$$

$$\nabla \vec{V} = 0, \quad (2)$$

with the following boundary condition in the top and bottom surface, accordingly.

$$\vec{V}(x, y, 0, t) = \vec{V}_0(x, y, t), \vec{V}(x, y, h, t) = \vec{V}_h(x, y, t). \quad (3)$$

In the assumption that the considered flow is always layered ($w(x, y, z, t) \equiv 0$) the solution can be written in the following form

$$\vec{V}(x, y, z, t) = (u(x, y, z, t), v(x, y, z, t), 0), \quad p = p(x, y, z, t), \quad \rho = \text{const}. \quad (4)$$

We suppose that the differentiable function $\varphi = \varphi(x, y, z, t)$ for different values of z and t exists. Therefore the velocity components $u(x, y, z, t)$ and $v(x, y, z, t)$ can be presented by the following equations

$$u(x, y, z, t) = \frac{\partial}{\partial x} \varphi(x, y, z, t), \quad v(x, y, z, t) = \frac{\partial}{\partial y} \varphi(x, y, z, t). \quad (5)$$

The equations (1) under mentioned before assumptions (4) and (5) have a solution, which can be written in the integral form

$$\begin{aligned} \frac{\partial}{\partial t} \varphi(x, y, z, t) + \frac{1}{2} \left(\left(\frac{\partial}{\partial x} \varphi(x, y, z, t) \right)^2 + \left(\frac{\partial}{\partial y} \varphi(x, y, z, t) \right)^2 \right) + \\ + \frac{P(x, y, t)}{\rho} - \frac{\mu}{\rho} \frac{\partial^2}{\partial z^2} \varphi(x, y, z, t) = q(z, t). \end{aligned} \quad (6)$$

For viscous flow (see for detail fig.2) we have get the initial-boundary problem of unsteady vortex flows, when the convective components are comparable to the viscosity components, we can write the equation

$$\frac{\partial \varphi}{\partial t} = \frac{\mu}{\rho} \frac{\partial^2 \varphi}{\partial z^2} - \frac{1}{2} \left(\left(\frac{\partial \varphi}{\partial x} \right)^2 + \left(\frac{\partial \varphi}{\partial y} \right)^2 \right) - \frac{P(x, y, t)}{\rho} + q(z, t) \quad (7)$$

with boundary conditions ($z = 0; h$):

$$(u, v) \Big|_{z=0} = \nabla_{xy} \varphi(x, y, 0, t) = (0, 0), \quad (8)$$

$$(u, v) \Big|_{z=h} = \nabla_{xy} \varphi(x, y, h, t) = \vec{V}_h(x, y, t), \quad (9)$$

and initial condition

$$t = 0: \quad \varphi(x, y, z, 0) = \Phi(x, y, z). \quad (10)$$

Therefore this method allows to analyze different three-dimensional with small depth streams in the assumption that considered flow is layer flow. The proposed method allows us to take into account the generation of moving vortex structures on the sharp edges of the border.

References

1. Cherniy D., Dovgiy S., Meleshko V. The Vortex Model of a Viscid Wall's Layer // IUTAM Symposium on "Vortex Dynamics: Formations, Structure and Function", Abstract Book, March 10(Sun)-14(Thu), 2013, Centennial Hall, Kyushu University School of Medicine, Fukuoka, Japan, P.P. 126-127.
2. Черний Д.И. Интеграл типа Коши-Лагранжа для нестационарных течений типа Hele-Shaw.// Труды XIV Международного симпозиума «Методы дискретных особенностей в задачах математической физики» (МДОЗМФ-2009).- Часть 1, Харьков-Херсон, 2009, - С. 185-187.

CONSEQUENCES – AN OFTEN FORGOTTEN PART OF RISK

Correll Raymond

Rho Environmetrics and CERAR, University of South Australia

Rho.Environmentrics@bigpond.com

Risk is often considered as a probability but an alternative definition includes both the probability of an event and its consequence or harm. This can be formalized as a product of likelihood and consequences or more practically as $\mathbf{Risk} = \sum_{k=0}^n p_k c_k$ where p_k is the probability of an event

k which would have a harm c_k . An estimate of the risk may be dominated by the potential harm. The talk will be illustrated by two examples.

The first taken from a risk assessment of fire starts from an electricity grid and how potential consequences (or harm) were estimated. That risk assessment was used to assess which part of the grid required upgrading and more importantly which parts did not require upgrading.

A second example is in the use of disease control in wheat production. The root disease can be controlled at a cost by using fungicides and the effectiveness of that can be obtained by an assessment of the plants. However the consequence of the disease control (as measured by grain yield) varies between seasons and between locations. Under some conditions control of root disease can give much larger yields but under some conditions disease control may result in lower yields. Formulation of this is an ongoing challenge.

Reference

1. Correll RL, Crisci F, Field JBF and Quick DG (1992). Optimum placement of insulated cable to reduce bushfire threat EECON'92 Brisbane Australia.

TECHNICAL AND PROGRAMMING SUPPORTIVE MEANS OF FOREIGN LANGUAGE LEARNING

Didmanidze Ibraim , Natalia Zoidze, Ketevan Zoidze

Batumi Maritime Academy, Georgia

Batumi Shota Rustaveli State University, Georgia

The given work aims at formation of the foreign language conceptual model with the help of practical usage of information-communicative technologies. The method will encourage the educational system reforms, it will improve the quality of the foreign language learning and teaching.

In order to reach the goals practically, the following main problems should be solved, such as:

- Defining the orients of practical usage of information communicative technologies in the process of foreign language teaching.
- Defining the communicative competence in foreign language teaching, to form and develop the modern conception;
- Working up the conceptual model of Information-communicative technology of foreign language teaching

By using the information technologies the adults conception is receiving the new character. The ability of modeling the situation increases the systematic mind, where the cultural and moral value takes part in realization and origination of the new technologies.

Today it is necessary to have the skills of getting information from the different sources, of using and creating them independently.

Using the information-communication technologies helps the foreign language teacher. New material, increases the effectiveness of teaching and learning, improves the quality of teaching and learning.

Information-communicative technologies are of great importance. These means implements the practical realization of teaching. They can be divided into two parts: technical and programmed means.

The basic goals of technical and programmed usage are the following:

- Increasing the motivation of teaching;
- Developing the speech competencies;
- Ability of Comprehension of authentic foreign text;
- Increasing the linguistic knowledge;
- Developing the talent and readiness for the learning of foreign language independently.

MULTILAYER NEURAL NETWORK

Didmanidze Ibraim, Kakhiani Grigol , Didmanidze Didar

Batumi Shota Rustaveli State University, Georgia

Learning efficiency of multilayered neural networks depends on quantity of layers in a network, quantity of neurons in the hidden layer and initial initialization of synoptic communications between neurons. For learning efficiency the architecture of a neural network plays large

role. Dimension of entrance and output layers of a neural network depends on a solved task and structure of a set of entrance data.

As it is known a three-layer neural network approximation practically any function with any in advance set accuracy is possible. Thus the accuracy of approximation depends on quantity of neurons in the hidden layer.

One of defects of a method of gradient descent is its "jamming" in local minima. For the purpose of overcoming of this defect possibly application of a so-called method of a heavy ball.

In this case modification of synoptic communications of a neural network happens according to the following expression

$$\Delta w_{ij}(t+1) = -\alpha \gamma_j F'(S_j) y_j + \gamma \Delta w_{ij}(t),$$

where γ - a constant called by moment parameter. Value of parameter of the moment undertakes from range [0,1] introduction of this parameter allows to overcome rather small local minima.

On the basis above stated it is possible to draw the following conclusions:

1. The neural network with one hid denlayerisable to display any entering signals in any proceeding signals;
2. The quantity of neurons in the hidden layer has to be less number of data in training selection;
3. Power of a neural network can be in creased both at the expense of increase in neurons in the hidden layer and at the expense of in crease in quantity of the hidden layers if a network influences #2 and the network is n'table tosol vean objective that it is necessary to increase quantity of the hiddenlayers.

Thus initialization of synoptic communications in a network has to occur in rather narrow range of values.

Adaptive speed of training of neurons of the penultimate hidden layer can be counted as follows $\alpha_2(t) = \frac{\sum_i C_i \sum_j (y_j - y_j) w_{ij}}{(F'(0))^2 \sum_j (\sum_i C_i w_{ij})^2},$

where $C_i = \gamma_i F'(S_i) (1 + \sum_k y_k^2).$

Here j number of an output layer of a neural network, i last hidden layer of a network, k penultimate hidden layer.

The expressions given above allow to estimate the adaptive speed of training of a neural network with one or several hiddenlayers.

APPLICATION OF APPROACH TO DECISION MAKING IN COUNTER TERRORISM ACTIVITY

Dolenko G., Lobach S.

Taras Shevchenko National University of Kyiv, Ukraine

GalinaDolenko2006@yandex.ua, s.w.a.t.oc.team@gmail.com

Terrorism prediction problem is completely pressing nowadays, especially since 9.11.2001. Main aim of our research was to check statistical hypothesis about distribution of intervals between terroristic acts and its parameters, and create a program dynamically updating data set. To achieve it, we suggested program engine which dynamically searches and accumulates information about terroristic acts on-line. Now database, generated by this program, includes over 12000 items for different countries. We consider ξ , interval between attacks, to be a random variable. The main hypothesis was in exponential distribution of ξ for attacks in the USA [1]. As we considered, research purpose was to define distribution parameter λ_0 . We used method of least squares to find it [2]. For examining main hypothesis we applied Kolmogorov-Smirnov test [2].

As a result, hypothesis wasn't declined by this test with any statistical significance level in bound $\alpha \leq 0,15$, which gives offences time distribution for studied sample for United states.

References

1. 2009 FBI report on terrorism – <http://www.fbi.gov/stats-services/publications/terrorism-2009>.
2. Прикладная статистика: Основы моделирования и первичная обработка данных. Справочное издание. С.А. Айвазян, И.С. Енюков, Л.Д. Мешалкин, – М.: Финансы и статистика, 1983. – 471 с.

ON ONE OF THE ALGORITHMS FOR OPTIMIZING CALCULATION PROCESSES IN THE LOCAL NETWORK

Donadze Mikheil , Imnaishvili Giorgi, Sirabidze Nukri

Batumi Shota Rustaveli State University, Georgia

Leading experts in the field of computing indicate the ultimate goal of development of information technologies is the creation of a system of „ubiquitous“ computing, which should provide access to information and means of processing it almost anywhere in the globe. To create such a system is necessary to address a set of interrelated technical problems and, above all, in the field of software distributed

computing resources. When creating software for distributed and multiprocessor systems programmer is faced with a number of technical challenges, which include: the unreliability of the circuit structure, the complexity of matching the speed of the plurality of functional units, but the main problem of distributed programming, and, in general, parallel computing systems is an adequate plan Developer system implementation in multiple computing processes. Ensure coordinated functioning in discrete systems of hundreds and sometimes even thousands of interrelated processes is impossible without fundamentally new approaches to building software systems.

Known formal apparatus describing concurrent systems in terms of communicating sequential processes C. Hoare has advantages when presenting the mutual influence processes, structuring, lack of divergences, deadlocks and possible formal proof of correctness in the design of computer systems to be submitted in the form of parallel composition of interacting subsystems. However, such a device does not have sufficient visual representation model, which makes it difficult in some cases, its use for the analysis of irregular distributed computing systems composed of different objects. Additionally, the unit interconnected sequential processes quite accurately describes the implementation of computing in the traditional multiprocessor systems (the most famous of which are representative of the cluster system) is inadequate to calculate conveyor systems.

Currently, there is a tendency of association in a single computing circuit computing components that focus on different types of high-performance computing: parallel computing, conveyor calculation, as well as various combinations thereof. For analysis of such systems there is a need of fundamentally new modeling tools for distributed computing that would have the advantages of the existing modeling tools and would have additional opportunities to ensure implementation of the analysis of parallel processes to a new level.

The advantage of the scheme in question.

- 1) B matrix performs a one-time input into the processors and then input of only vector-rows $A[i]$ (minimization of the data flow).
- 2) The function capacity of the processors are automatically calculated. If the processor functions faster it gets additional load (the $k < m$ case).

The system offers the following possibilities:

- 1) The receipt of the data about the system:
 - the number of the processors (machines) that are engaged in calculations.

- the management of each processor resource (type, memory capacity, speed).
- 2) The management of the data flow among processors:
 - creation of the connection channel between any two processors;
 - management of the channels re-addressing;
 - receipt of the information on the data processing speed per specific arch (localizing „narrow spaces“);
 - setting the desired speed for the data flow on each arch.
 - 3) Launch of a task on each processor by the machine.
 - 4) Reporting on the status of the ongoing task (error, hung, etc.)
 - 5) For a group of processors, the simultaneous data transfer via broadcast means of local networks, i.e. simultaneously via several channels.

HOUGH - PAIRS OF SPACES IN A CHARACTERS RECOGNITION PROBLEM

Donchenko V., Zinko T.

Taras Shevchenko National University of Kyiv, Ukraine

voldon@bigmir.net

General Hough transform scheme (Hough pair of spaces) was described in [1]. Basic content of the construction proposed is spreading in the general case the main structural elements of the classical variant of Hough Transform (HT) [1]. This is primarily required replacing the parametric family of the curves since just that family is the basis of all HT construction.

Specificity, abstract version of HT consists of the next structural constituents. Firstly, these are two abstract sets – “spaces”: S_o – called observations space with elements $s \in S_o$, called observations; S_p – called parameters space with elements called parameters. Secondly, – two families of subsets in each of two “spaces”, mutually parameterized by the elements of the “conjugate” spaces. Besides, they are agreed upon with each other in the certain way. Namely these families are denoted correspondingly: $G_\theta \subseteq S_o, \theta \in S_p$ and $L_s \subseteq S_o, s \in S_o$, and the agreeing condition (matched condition) is as follows:

- o for any $\theta \in S_p$ of what $s \in G_\theta$ follows that $\theta \in L_s$: $s \in G_\theta \Rightarrow \theta \in L_s$,
- o for any $s \in S_o$ of what $\theta \in L_s$ follows that $s \in G_\theta$: $\theta \in L_s \Rightarrow s \in G_\theta$.

In the classical HT construction fulfilling of matched condition is the subject of the theorem.

Subsets $G_\theta, \theta \in S_p$ are denoted as “curves”, $L_s, s \in S_\theta$ – as Hough transform of observation $s \in S_\theta$.

The rest elements of HT construction remains the same: a sequence of observations $s_1, \dots, s_n \in S_\theta$, HT of the sequence of the observations: $L_{s_1}, \dots, L_{s_n}$, accumulator function and Hough-estimator [2,3].

An example of described above Hough-pair construction, which is important in applications, is the such one in which: “curve” is a set of pixels in a display representing the character from this or that collection of characters. The set of these characters is the parameter space of the Hough-pair, while a Hough – transform of the pixel is the subset of the character collection, including the pixel as the element of a display symbol representation.

Theorem 1. The quaternary S_o – a set of the pixels, used for symbol representation, S_p – some collection of symbol, $G_\theta \subseteq S_o, \theta \in S_p$ – pixels subsets, represented each of the symbol θ from S_p – are together a Hough-pair of spaces.

It should be noted that one more Hough pair could be designed regarding a symbol collection. Collection of the curves in this new one is collection of “discretized” subsets of correspondent pixels.

This concept in [4] was used for character recognition by the its images particularly for symbols recognition on automobile license plates. The approach on the base of Hough-pair conception showed high efficiency.

References

1. Донченко В.С. Абстрактний варіант перетворення Гока для розпізнавання символів / В.С. Донченко, Зінько Т.П. // Тези міжнародної конференції “Проблеми прийняття рішень в умовах невизначеності” PDMU-2014, 12-16 травня, Мукачево, 2014. –С. 99-100.
2. Donchenko V. General Scheme of the Hough Transform and the Properties of the Hough estimation in the special case of Discrete Spaces // Statistical research report S-901 87. – University of Umea, Sweden.– June, 1994.– 10 p.
3. Донченко В.С. Множинний підхід до опису невизначеності в математичному моделюванні: дис. на здобуття наук. ступеня докт.

фіз.-мат. наук: спец. 01.05.04 «Системний аналіз і теорія оптимальних рішень» / Донченко В.С.; Київський нац. ун-тет ім. Т. Шевченка. –Київ, 2007. –349 с.

4.Зінько Т.П. Аналіз і синтез алгоритмів розпізнавання й класифікації та їх застосування в обробці мовних сигналів і зображень: дис. на здобуття наук. ступеня канд. тех. наук: спец. 01.05.04 «Системний аналіз і теорія оптимальних рішень» / Зінько Т.П.; Київський нац. ун-тет ім. Т. Шевченка. –Київ, 2012. –173с.

GENERELIZING OF ARTIFICIAL NEURO NETS

Donchenko V.

Taras Shevchenko National University of Kyiv, Ukraine
voldon@bigmir.net

Artificial neural nets (ArtNN) with hidden layers is a technology, that is widely used in applications (see, for example, [1]). In essence they implement superposition functions of special parametric family of functions.

But some faults of the ArtNN are obvious, namely, the constraints on the primary functional elements represented by neurons, constraints on topology, constraints on the optimizations, properly in the appearance of the Back Propagation.

In the report the attempt is undertaking to extend the ArtNN up to Functional nets taking as the primary the special functional element – so called ERRT: elementary recursive regressive transformation, spreading the topology and introducing “natural” optimizing parameter. The fulcrum for the implementing this attempt arises from the theory of Moore -Penrose Pseudo Inverse Matrixes (see, for ex. [2]) developed by Kirichenko [2].

The approach proposed is realized in the conception of so called Recursive nonlinear Functional Transformation - Functional Net (RFT-FN). The idea of such type transformations in the variant of direct recursion was introduced and discussed in the paper [4]. As it has been already noticed earlier, RFT – FN embodies the main ideas of the classical ArtNN: using the composition of standard primary functional elements (artificial neurons – a.n.) connected according some topology for constructing a complex object. The primary elements of the

composition: a.n. – represents mathematically comparatively simple function: a composition of linear function – linear functional for input multi- dimensional variable, – and simple standard scalar function. Conception of the RFT-FN leaves the main idea of ArtNN unchangeable: that the idea of constructing a complex objects through a composition of standard simple ones. But it is proposed and implemented some substantial refinements. The main of them are actually in the next: enriching the domain of the feasible functions for the basis standard functional elements and introducing the special procedure for the adjusting for the newly connecting ERRT; introducing the special recursive dynamic procedure for the constructing the RFT-FN; enriching the topology of connections; adaptive construction of functional net. There are some more additional enhancements for the ArtNN, proposed and implemented in the conception of the RFT – FN. These are: coordinate wise nonlinear transformations of the input and intermediate inner coordinate along with the linear transformations of them. All the refinements make it possible to optimize the constructing of the RFT-FN on the each recursive step and wholly by the next ways: by the choice of the feasible functions for the ERRT, by the choice of linear transformations of its coordinates and coordinate wise nonlinear transformations of the coordinate for the input variables for the newly connected ERRT: single or a number of them.

References

1. Veelenturf L.P.J., Analysis and applications of artificial Neural Networks.–Prentice Hall (UK).– 1995.–259 p.
2. Ben-Israel, A. and Greville, T. N. E. Generalized Inverses: Theory and Applications. New York: Wiley, 1977.
3. Кириченко Н.Ф. Аналітичне представлення збурень псевдообратных матриц. // Кибернетика и системный анализ. – 1997.–№2.–С.98-107.
4. Donchenko V.S., Kirichenko N.F., Serbaev D.P.. Recursive regression transformations and dynamical systems.// Proceedings of the Seventh International Conference “Computer Data Analysis and modelling: robustness and computer intensive methods”.– V.1.– September 6-10, 2004. – Minsk (Belarus).– p.147-151.

MOBIUS INTEGRATORS FOR CONTROL PROBLEMS

¹ Frank, J., ² Zhuk, S.

¹Utrecht university, The Netherlands

²IBM Research - Ireland

j.e.frank@uu.nl, sergiy.zhuk@ie.ibm.com

The paper presents symplectic Mobius integrators for Riccati equations arising in linear quadratic optimal control problems. All proposed methods preserve symmetry, positivity and quadratic invariants for the Riccati equations, and non-stationary Lyapunov functions. In addition, an efficient and numerically stable discretization procedure based on reinitialization for the associated linear Hamiltonian system is proposed. An efficacy of the proposed methodology is illustrated by applying an implicit midpoint version of the Mobius integrator to a Riccati equation associated with Galerkin projection of a linear hyperbolic equation.

References

1. Frank, J. And Zhuk, S. Symplectic Mobius integrators for LQ optimal control problems, CDC14 (submitted).

STUDY OF A MODEL OF ENVIRONMENTAL "PREDATOR-PREY" WITHOUT AGE STRUCTURE

Garkusha N.

Taras Shevchenko National University of Kyiv, Ukraine

n@gmail.com

In this paper the mathematical model of population growth and interaction of "predator-prey" is considered with the following assumptions [1]: the density of the species, i.e. number of individuals per unit area can be completely described by a single variable (ignore the age, sex and genetic differences); changes in density can be adequately described by deterministic equations; results of the interaction within and between species occur with some delay (puberty).

Then the model can be represented by a system of two differential equations following form

$$\begin{aligned}\dot{x}(t) &= ax(t) - bx^2(t) - cx(t - \tau)y(t - \tau), \\ \dot{y}(t) &= ey(t) - f \frac{y^2(t - \tau)}{x(t - \tau)}.\end{aligned}\tag{1}$$

A qualitative study of systems with aftereffect. Special interest is the point lying in the positive quadrant:

$$\hat{I}_2(x_2, y_2), \quad x_2 = \frac{af}{bf + ce}, \quad y_2 = \frac{ae}{bf + ce}.$$

The system of "perturbation equations" linearized in a neighborhood of $\hat{I}_2(x_2, y_2)$, take the form

$$\begin{aligned} \dot{\xi}(t) &= (a - 2bx_2)\xi(t) - cy_2\xi(t - \tau) - cx_2\eta(t - \tau), \\ \dot{\eta}(t) &= e\eta(t) + f \frac{y_2}{x_2} \left[\frac{y_2}{x_2} \xi(t - \tau) - 2\eta(t - \tau) \right]. \end{aligned}$$

A study of the singular point $\hat{I}_2(x_2, y_2)$ was done. The influence of the aftereffect on the dynamics of the system is reviewed (1).

References

1. Smith J. The models in the ecology. – M., Mir, 1976. – 184 p.

FILTERING PROBLEM FOR PERIODICALLY CORRELATED STOCHASTIC PROCESSES

Golichenko I.I.

National Technical University of Ukraine "KPI", Ukraine

idubovetska@gmail.com

We consider the problem of mean square optimal linear estimation of the functional $A^f \zeta = \int_0^\infty a(t) \zeta(-t) dt$ that depends on the unknown values of periodically correlated stochastic process $\{\zeta(t), t \in \mathbb{R}\}$ [1] based on observations of the process $\zeta(t) + \theta(t)$ for $t \leq 0$. The noise $\{\theta(t), t \in \mathbb{R}\}$ is uncorrelated with $\zeta(t)$ periodically correlated process. This problem is studied for two cases: spectral certainty (spectral densities are known) and spectral uncertainty (a class of admissible densities is given).

Let spectral density matrices $f(\lambda)$ and $g(\lambda)$ of stationary sequences $\{\zeta_j, j \in \mathbb{Z}\}$ and $\{\theta_j, j \in \mathbb{Z}\}$, which are induced by processes $\zeta(t)$ and $\theta(t)$, respectively, be known. The classical Kolmogorov projection method allows us to find formulas for calculating the spectral characteristic $h(f, g)$ and the mean square error $\Delta(f, g)$ [2] of the optimal linear estimate of functional $A^f \zeta$:

$$h^\top(f, g) = \left(A_-^\top(e^{i\lambda})f(\lambda) - D^\top(e^{i\lambda}) \right) [f(\lambda) + g(\lambda)]^{-1},$$

$$\Delta(f, g) = \Delta(h(f, g); f, g) = \langle a, Wa \rangle + \langle d, Ud \rangle.$$

In the case of spectral uncertainty the minimax-robust approach to estimation problem is used. That is we find estimate that minimizes the mean square error for all spectral densities from a given class simultaneously.

References

1. Gladyshev E. G. Periodically and almost periodically random processes with continuous time parameter // Theory Probab. Appl. – 1963. – Vol. 8. – P. 173-177.
2. Dubovets'ka I., Moklyachuk M. On minimax estimation problems for periodically correlated stochastic processes // Contemporary Mathem. and Stat. – 2014. – Vol. 2, No. 1. – P. 1-24.

APPLICATION OF STOCHASTIC OPTIMIZATION PROCEDURE TO INVESTMENT PORTFOLIO PROBLEM

Gorun P. P.¹, Chabanyuk Ya. M.²

¹Lviv Polytechnic National University, Ukraine

²Lviv State University of Life Safety, Ukraine

pavlo.gorun@gmail.com

Optimal portfolio of Markowitz model [1] has the following simplified form [2]:

$$\left\{ \begin{array}{l} r(u) = \sum_{i=1}^d r_i u_i \rightarrow \max, \\ \tilde{C}(u; x) = \sum_{i=1}^d \sum_{j=1}^d S_{ij}(x) u_i u_j \rightarrow \min, \quad S_{ij}(x) = c_{ij} x_i x_j, \end{array} \right.$$

where $r_i = r_i(t)$ – return on i -asset, $x_i = x_i(t)$ – the risk of adverse changes in market quotations for i -asset, $c_{ij} = c_{ij}(t)$, $j=1, \dots, n$ – correlation coefficients of random variables of return on assets (risk of adding to the portfolio of i - and j -type of asset).

And stochastic optimization procedure (SOP) with Markov switching in series scheme is given by formula (let $\sum_{k=0}^{-1} a_k^\varepsilon C(u_k^\varepsilon, x_k^\varepsilon) = 0$) [3]

$$u^\varepsilon(t) = u_0 + \varepsilon \sum_{k=0}^{v(t/\varepsilon)-1} a_k^\varepsilon \nabla_b C(u_k^\varepsilon, x_k^\varepsilon), t \geq 0, u^\varepsilon(0) = u_0, u \in R^d,$$

where $u \in R^d$, and $v(t) = \max\{n: \tau_n \leq t\}$ – counting process of restoring $\tau_n, n \geq 0$ embedded Markov chain $x_n = x(\tau_n), n \geq 0$ in uniformly ergodic Markov process $x(t)$ in dimensional space $(X, \mathbf{X})$ with generator Q and potential R_0 [4, Subsection 1.6]. Pseudo gradient ∇_b is according to the rule

$$\nabla_b C(u, \cdot) = ((C(u_i^+, \cdot) - C(u_i^-, \cdot)) / 2b(t), i = \overline{1, d}),$$

$$u_i^\pm = u_i \pm b(t)e_i, e_i = \{0, \dots, 1, 0, \dots, 0\}.$$

Sufficient conditions for convergence of this procedure is in [4]. Described SOP was applied to the search problem of optimal investment portfolio. Simulation results confirm the good convergence of procedure. So, even with partial data on selected assets and their behavior, the use of SOP enables to find the point of extremum for chosen regression function.

References

1. Markowitz Harry. The Optimization of a Quadratic Function Subject to Linear Constraints //Naval Research Logistics Quarterly, 1956. — Vol. 3. — P. 1–33.
2. Tolochko Yu.M. A two-level mathematical model for finding the optimal portfolio by sequential groups of equal criteria. //Collection of articles edited by Kovalev M.M. Minsk: BGU, 2003. — P. 233–257.
3. Gorun P.P. Generator of jumping optimization procedure in Markov medium /Gorun P.P., Chabanyuk Ya.M., Kukurba V.R. //XVI International Conference "Problems of decision making under uncertainties": PDMU-2010, October 4-8, 2010. Kyiv: Osvita Ukrainy. – 2010. – P. 54.
4. Gorun P.P. Convergence of jumping optimization procedure in Markov medium /Gorun P.P., Chabanyuk Ya.M., Gnativ L.B. //XVII International Conference: Problems of decision making under undertainties, 23-27 may 2011. Kyiv: Osvita Ukrainy. – 2011. – P. 58-59.

METHODS OF INTELLIGENT MODELING OF ECONOMIC AND MANUFACTURING PROCESSES FOR MANAGERIAL DECISION SUPPORT SYSTEMS

Gritsenko V., Timashova L.

International Research and Training Center for Information Technologies and Systems of National Academy of Sciences of Ukraine and Ministry of Education and Sciences of Ukraine
dep190@irtc.org.ua

At the present moment economic and manufacturing systems are under conditions of the highly unstable economic environment. Therefore, an efficient support of the decision making process is necessary to take the reasonable managerial decisions under such circumstances. Uncertainty is a fundamental feature of the insufficient provision with the knowledge about a certain problematical situation in order to support the decision making process in the field of management and economics. On this point any managerial decision should be grounded on the possibility to take into consideration incomplete data. Also any managerial decision should be based on the intelligent tools for modeling in order to increase the level of efficiency of the managerial decisions.

The present day there is an issue of current importance to determine the main factors that stipulate for the ways of the negotiation of the nascent negative economic phenomena. It is necessary to use the contemporary mathematical apparatus to determine the strategy of the efficient management for the economical and manufacturing systems. Particularly, for such purpose we should use the intelligent modeling based on the knowledge extraction and realization in the intellectual systems for the infotainment of the managerial decisions on different levels. The urgency of these issues is determined by the urgent need in the scientifically based, contemporary, comprehensible, and easy-to-operate methods and new technologies for the decision support systems for the management activity on different levels.

At the present moment an analysis of the scientific results both in our country (V. M. Glushkov Institute of Cybernetics of National Academy of Sciences of Ukraine, T. Shevchenko National University of Kyiv, National Technical University of Ukraine, Institute of Artificial Intelligence (city of Donetsk), etc) and abroad (Institute of Control Sciences and Institute for System Programming of Russian Academy of Sciences (RAS), St. Petersburg Institute for Informatics and Automation of RAS, Lomonosov Moscow State University, such American

institutions as Princeton University, University of Massachusetts, Stanford University, Columbia University, etc) show that in spite of the numerous researches in this field there is an urgent need in the comprehensive research and application because there are still many gaps in the surveys to deal with the state-of-the-art challenges [1,2].

The goal of the researches in these matters is to develop a theoretical footing for the methods and tools for intelligent modeling of processes defined by incomplete and uncertain data. This theoretical basis should be used for the decision support systems to take managerial decisions on the different levels in the constantly changing environment. The methods' and intelligent modeling technologies' development is the result of the researches in this field. It synthesizes accomplishments in the field of traditional methods of mathematical modeling with the systems based on the knowledge and the tools for intelligent analysis of data. A new concept of the forming and development of the knowledge-oriented methodology for intelligent modeling is also a terminal product. This new concept synthesizes accomplishments in the field of traditional methods of mathematical modeling with the systems based on the knowledge and the tools for intellectual analysis of data. Also it synthesizes new high-performance algorithms of the intelligent modeling for the multivariate interconnected processes. These processes are based on the knowledge-oriented technologies to intellectualize the process of the managerial decision making support on different levels.

The main idea of these researches is to synthesize accomplishments of the mathematical modeling methods, knowledge-oriented approaches of artificial intelligence, and the intelligent analysis of data. It will provide the tools of managerial decision support with features peculiar to the human intelligence. Thus, it will increase efficiency of decision making. Furthermore, intelligence systems will enrich the potentialities to execute difficult tasks in the constantly changing environment because they contain knowledge and technologies. Such systems process information purposefully taking into consideration the experience. This experience is acquired in the process of the problem solving in the environment of incomplete and undetermined current information.

General economics, systems analysis, knowledge representation methods, economical and mathematical methods and models, information technologies and intelligent information systems, a theory of decision making in the environment of uncertainty, colliding and risk caused by them were used to develop the technology.

The technology of the intelligent modeling for the social-economic and manufacturing processes is an applied product. These processes are characterized by incomplete and uncertain information. The technology is designed for the managerial decision support systems of different levels in the constantly changing environment.

Summary. This line of investigation is of current importance. It should be developed and accomplished with help of the up-to-date software.

NUMERICAL SIMULATION OF THE PROCESS OF OPTICAL RADIATION IN THE DEFORMING MEDIUM

**Gryshchenko Oleksandr¹, Zagorodnia Ganna²,
Onotskyi Viacheslav³**

Taras Shevchenko National University of Kyiv, Ukraine

¹**O**Gryshchenko@ukr.net, ²**anja145**@ukr.net,

³**vingar**@unicyb.kiev.ua

The general models of processes of adaptive or quasilinear optics are known from 80th years of the last century [1,2]. It is science which is on a side between engineering development and scientific researches. It is engaged in studying of optical high-energy radiation distribution process in the being deformed environment. It found the practical application in the industry, medicine, in astronomical researches.

Nonlinearity of high-energy beams distribution is explained first of all by non equilibrium change of the environment density in which the bunch of beams extends. Such interaction of a power field and temperature of the environment is described by system of the equations of transfer for complex-valued function of energy and the energy balance equation. Change of a power condition of the environment leads to change of light penetration coefficient, and also to deformation which in turn creates the deforming force which influences the direction of beam movement.

Besides, in case of beams bunch distribution in the atmospheric environment it is necessary to consider movement of air masses which is described by Navier-Stokes equations.

Mathematical model of such phenomena it is investigated more not enough.

In our work one of possible ways of numerical modeling of energy distribution processes in such tasks is offered. It is offered modification of two-step DS-algorithm [3]. It is investigated properties of numerical model. Testing is held.

References

1. Воронцов М.А. Шмальгаузен В.И. Принципы адаптивной оптики. М. Наука 1985. – 335с.
2. Канев Ф.Ю., Лукин В.П. Адаптивная оптика. Численные и экспериментальные исследования. - Томск.: Изд-во Института оптики атмосферы СО РАН, 2005. – 250 с.
3. Грищенко О.Ю, ДС – різницеві алгоритми розв'язування крайових задач для параболічних рівнянь другого порядку// Вісник Київського університету .Серія фіз.-мат. науки.- 2000, В1. –С.227–231.

ESTIMATION OF EXTREME VALUES: A CASE STUDY FOR THE INTENSITY-DURATION-FREQUENCY CURVES ASSESSMENT*

Jan Holešovský¹, Jaroslav Michálek²

¹Brno University of Technology, Czech Republic

²University of Defence, Czech Republic

honza.holesovsky@gmail.com, michalek@fme.vutbr.cz

The extreme value theory is widely applied in order to estimate the frequency of rare and extreme events. However, the increasing demands on protection of human and their properties give a rise to requirement for more accurate prediction and estimation. The purpose of the contribution is to introduce and compare several parametric and nonparametric techniques meant for extreme value index estimation under the assumption of a threshold model. The nonparametric estimators make use of high enough order statistics, which are selected on the basis of double bootstrap methodology [1]. Both approaches are further applied to estimation of intensity-duration-frequency curves, which represent an important tool in hydrological praxis. The properties of estimators and their impact on the curves estimation are discussed.

References

1. Gomes, M. I., Oliveira, O. (2002). The Bootstrap Methodology in Statistics of Extremes – Choice of the Optimal Sample Fraction. In *Extremes* 4(4): P.331-358.

Supported by research project “Risk Phenomena Modelling” No. SV14-FEM-K101-01-MICH, University of Defence.

* Supported by research project “Risk Phenomena Modelling” No. SV14-FEM-K101-01-MICH, University of Defence.

UNCERTAIN LINEAR SYSTEMS OF INEQUALITIES: STRONG SOLVABILITY AND STRONG FEASIBILITY

Oleg Iemets, Oleksandra Yemets`

Poltava University of Economics and Trade, Ukraine

yemetsli@mail.ru; yemets2008@ukr.net

The system of inequalities with data in the form of fuzzy numbers is considered in the report. The strong solvability and strong feasibility of uncertain linear systems of inequalities are investigated. Criteria of strong solvability and strong feasibility of uncertain linear systems of inequalities are received on five grades: exact, quasi-exact, semi-uncertain, quasi-uncertain and uncertain grades.

The concepts of fuzzy number, its membership function and the carrier; a continual and discrete fuzzy number; the peak (acute and nonacute) of a fuzzy number; a normal fuzzy number; a standard fuzzy number; a standardized fuzzy number; an interval matrix and its upper and lower bounds; the middle matrix and the matrix of radiuses for an interval matrix; an interval vector and its upper and lower bounds; the middle matrix and the matrix of radiuses for an interval vector; a fuzzy matrix; the interval linear system of inequalities; a fuzzy system of linear inequalities are introduced for this aim.

The definitions of solvability and feasibility, strong solvability and strong feasibility; strong solvability and strong feasibility of the system of linear inequalities on five grades: t ($t \in \{0, 1, 2, 3, 4\}$) are presented in the report.

Theorems-criteria of strong feasibility and strong acceptability of uncertain linear system of inequalities in the five grades are formulated and proved.

It is planned to use these facts in optimization problems with uncertain data in the future.

References

1. Sergienko I. V. Systems of Linear Equations with Fuzzy Set Data: Weak Solvability and Weak Admissibility / I. V. Sergienko, O. O. Iemets, O. O. Yemets // Cybernetics and Systems Analysis. – 2014. – V.50, I.2. – P. 191-200.

ONE ALGORITHM FOR THE TWO-LEVEL MODEL OF PRODUCTION AND TRANSPORTATION PROBLEM SOLVING

Ivokhin E., Adzhubey L., Almodars Barrak Subhi Kaml

Taras Shevchenko National University of Kyiv, Ukraine

ivokhin@univ.kiev.ua, adzhubey@ukr.net

Principles of block optimization [1] simplify analysis, decision and meaningful response of many problems of planning and management. Through these methods can be divided into a complex production-transportation problem to autonomous production planning problem and organizing the delivery of products. On the other hand, interpretation of the results in terms of content often enough to determine sustainable approaches functioning of various economic and technical systems [2].

Traditional production and transportation problem is to determine the production and transportation plan, minimize the total costs which are related to the organization of production and transportation of manufactured products to the points of consumption.

Assume that each consumer can satisfy their need for products only by one manufacturer. This problem can be formulated as the linear mixed-integer programming problem [3].

To create an effective method for solving of the obtained problem it is carried out a modification of the general method of the problem solving with considering the features of the two-level problem. There is proposed to find the optimal solutions by using the iterative scheme [1].

This algorithm has been proposed for solving the problem of efficient allocation of capacity data links between the nodes of the network providers and users, taking into account both the needs and benefits of subscribers and providers capacity. It has the sufficiently high computational efficiency, what means about constructive application of the proposed algorithm for the optimization problems with two levels of formalization.

References

1. Юдин Д.Б. Экстремальные модели в экономике/ Д.Б.Юдин, А.Д.Юдин. – М.: Экономика, 1979. – 288с.
2. Волконский В.А. Принципы оптимального планирования/ В.А.Волконский. – М.: Экономика, 1973. – 216с.
3. Lukac, Z., Hunjet D. and Neralic L. (2008) Solving the production-transportation problem in the Petroleum Industry// Revista Investigacion Operacional. V.29. №1. – P.63–70.

ON ANALYSIS OF FUTURES MARKETS BY MONTE CARLO METHOD

Kakoychenko A.

Taras Shevchenko National University of Kyiv, Ukraine

a.kakoychenko@gmail.com

The financial markets pricing process is unambiguously described by flows of transactions. There are three most popular types of transactions: add order, remove order and modify order. The model allows passing from problem of pricing prediction to sub problems of transactional flows prediction.

The process of model developing and testing required specialized computer simulation software. The original program “Watcher” is used for this purposes. This software is able to store and analyze market data, perform tests of strategies and help with the development of trading strategies. The data about transactions, provided by Moscow Exchange, is also used in this research.

Many scientists consider the time intervals between two transactions as exponential or gamma-distributed [1],[2]. But the analysis of transactional flows proved, that this assumption contradicts the reality. The model based on the range of frequencies is employed for the approach. Nevertheless, the problem of evaluating the analytical distribution formula is considered to be still actual.

Using this model to modeling and predicting the market states requires model estimation. The estimation algorithm is also proposed.

References

- 1 Avellaneda M., Stoikov S. High-frequency trading in a limit order book //Quantitative Finance. – 2008. – T. 8. – №. 3. – C. 217-224.
- 2 Korolev V. Y. et al. Probability and statistical modeling of information flows in complex financial systems based on high-frequency data //Informatika i Ee Primeneniya . – 2013. – T. 7. – №. 1. – C. 12-21.

THE CLASSICAL AND QUANTUM DECISION MAKING LOGIC

Jan Kaluski

Chorzow School of Banking, Chorzow, Poland

jan.kaluski@polsl.pl

In the work some problems of quantum decision making with comparing to the classical logic are presented. Based to Bell’s theorem (1964) and many works of famous physicians as Einstein, Bohr,

Heisenberg, Born, Schroedinger, von Neumann and others which hold fast to the concept of new logic, the hard way of development of quantum logic in decision making is discussed. Simultaneously in the paper the I. Kant's formal logic, Łukasiewicz-Tarski's truth theory and logic across the Jacyna-Onyszkiewicz's cosmological theory and Buddhism's philosophy are presented. To decision making in the concrete situations some models of quantum information theory, quantum probability and first of all quantum game theory are used. On the number of examples according to detailed computing of the quantum probability and construction of the quantum strategies in the games, the methods of calculating are showed. In all mentioned discussion shows that these methods are different from classical methods.

The work consists of 7 parts. The first part a genesis of classical and quantum logic as well as literature is presented. The aim of the work has been formulated by comparing analyses of the classical and quantum logic in the models of decision making in theoretical and practical aspects. Many historical, philosophical and just esoterical facts into consideration was taken.

In the second part the genesis and properties of the quantum logic are presented. In the third part some elements of the quantum probability theory in comparison with the Kolmogorov probability theory is discussed. An example calculating of the quantum probability and classical (Kolmogorov) probability is done.

In the fifth part the quantum game theory with the many examples is discussed. Many kinds of game are presented in the aspects of transformation the classical sets of game to quantum sets.

In the sixth part the quantum entangled states of atomic systems is discussed. In the last part a reassume concerning of the all problems covered in work is done.

References

1. Einstein A.: W: M. Born (ed, The Born-Einstein Letters, Maimilian, London, 1977.
2. Bell J. S.: On the Einstein – Podolsky – Rosen paradox, Physics 1: 15-200, 1965.
3. Quantum Theory and Measurement. Edited by John Wheeler and Wojciech H. Żurek. Contains reprint of other landmark papers, including translation of Erwin Schroedinger, 1935. "cat paradox" paper – Princeton University Press, 1983.

4. E. W. Piotrowski and J. Ślaskowski: Quantum like Approach to Financial Risk: Quantum Antropic Principle, Acta Phys. Pol. B32 (2001) 3873-3879.
5. Kałuski J.: Game-Theoretical Model of the Assembly Line Balancing Problem. International Journal of Mathematics, Game Theory and Algebra. Nova Science Publishers, Inc. 1998.
6. Kałuski J.: A multi-stage programming method for solving n-person games with coalitions. SILS-MARIA Workshop on Dynamic Games and Applications. The ISDGI Proceedings, 1997..
7. Eisert J., Wilkens M. and Lewentstein M.: Quantum Games and Quantum Strategies, Phys. Rev. Lett. 83, 3077 (1999).

APPROXIMATE SYNTHESIS IN IMPULSE DISTRIBUTED OPTIMAL CONTROL PROBLEM WITH RAPIDLY OSCILLATING COEFFICIENTS

Kapustyan O.V., Kapustian¹O.A., Rusina A.V.

Taras Shevchenko National University of Kyiv, Ukraine

¹ olena.kap@gmail.com

For a wide class of problems with both distributed [1] and concentrated control [2] without restrictions it is possible to obtain a closed optimal synthesis, parameters of which are expressed in terms of the eigenfunctions and the eigennumbers of the corresponding differential operator. In the case of rapidly oscillating coefficients in such operator the task is to substantiate the approximate average synthesis formula [3], [4]. In this work from this point of view we consider a parabolic problem with distributed control and impulse controlled action [5]. On the basis of the found formula of exact synthesis we propose and prove procedure for constructing approximate average synthesis, which consists in replacing all rapidly oscillating parameters in the exact solution formula for the average ones and in replacing all infinite sums for the finite ones.

References

1. Егоров А.И. Оптимальное управление линейными системами. - К.: Вища школа, 1988. - 278 с.
2. Белозеров В. Е., Капустян В. Е. Геометрические методы модального управления. - К.: Наукова думка, 1999. - 260 с.
3. Секретна А.В., Капустян О.А. Наближений усереднений синтез задачі оптимального керування для параболічного рівняння. // Укр. мат. журн. - 2004. - Т. 56, № 10. - С. 1384 - 1394.

4. Капустян О.В., Секретна А.В. Усереднений синтез оптимального керування для хвильового рівняння // Укр. мат. журн. – 2003. –Т. 55, № 5. –С. 612 – 620.
5. Самойленко А.М., Перестюк Н.А. Дифференциальные уравнения с импульсным воздействием. – К.:Вища школа, 1987. – 289 с.

INFORMATION OPERATOR AND OPTIMAL ALGORITHMS IN PROBLEMS OF MEASUREMENT AND DETECTION

Kasyanyuk V.S.

Taras Shevchenko National University of Kyiv, Ukraine

veda.sia@mail.ru

Radio-location parameters' Pareto-optimal estimations [1] in measuring task also as detection' optimal algorithms are tightly related to Fisher information operator in problems of measurement and detection.

In case when radio-location parameters' vector $x = (x_1, \dots, x_n)^T$ is estimated on measurements' data $y = (y_1, \dots, y_m)^T$

$$y = Ax + \nu, \quad (1)$$

where $A = (a_{ij})_{i=1, j=1}^{n, m}$ is matrix that characterizes measuring device and $\nu = (\nu_1, \dots, \nu_m)^T$ are measurements' noises, $M(\nu) = 0$, $M(\nu\nu^*) = R$, $\det R \neq 0$, then Pareto-optimal estimation $\hat{x}$ looks like

$$\hat{x} = A^*(AA^* + \omega R)^{-1} y, \quad \omega > 0. \quad (2)$$

The estimation is accompanied by a background noise with level $h(\omega) = \text{tr} A^*(AA^* + \omega R)^{-1} R(AA^* + \omega R)^{-1} A$, which decreases monotonous when ω increases, and operator residual characterizing estimation' $\hat{x}$ displacement $\varphi(\omega) = \text{tr}(A^*(AA^* + \omega R)^{-1} AA^*(AA^* + \omega R)^{-1} A - 2A^*(AA^* + \omega R)^{-1} A + E)$, which increases monotonous with the growth of ω . Choosing ω background noise' level and the estimation' operator residual value can be controlled.

Equation (1) linear transformation with the matrix A^*R^{-1} leads to $A^*R^{-1}y = A^*R^{-1}Ax + A^*R^{-1}\nu$. The equation matrix is the Fisher information operator $F = A^*R^{-1}A$. As shown, de-correlated equation' (1) solution represented as a decomposition by the eigenvectors of matrix F coincides with the Pareto-optimal estimation (2) corresponding $\omega = +0$.

The obtained solution's properties are considered.

References

1. Белов Ю.А. Математичні методи і алгоритми обробки в задачі інтерпретації непрямих вимірювань / Белов Ю.А., Касьянюк В.С. – К.: Науковий світ, 2000. – 79 с.

DATA CLUSTERING USING THEORETIC- POSSIBILITY APPROACH

Kasyanyuk V., Malutenko L.

Taras Shevchenko National University of Kyiv, Ukraine

tk@unicyb.kiev.ua

The problem of data set effective partition into equivalence classes using clustering algorithms is of a great practical importance. While solving the problem, the task of choosing clustering algorithm's adequate parameters can occur. In case of un-appropriate parameters choice, the obtained partition will not meet experiment's requirements, but even if parameters' choice was made successfully, questions can often appear in regard of correct linking of data set's certain subsets to one or other cluster. We propose an approach to clustering based on the possibilities theory [1]. It allows us to consider inconclusiveness and ambiguity of clustering algorithm's parameters' selection when such parameters are given as a fuzzy value or fuzzy variables' vector.

The mathematical model is based on concepts of fuzzy cluster and fuzzy partition. Let D is a finite data set, $\mathcal{D}$ is a set of admissible partitions of D into equivalence classes, $\alpha: X \rightarrow \mathcal{D}$ is a clustering algorithm that makes a certain partition of D depending on parameters 'vector's value $x \in X$. Let us call mappings 'system $\{C_i\}_{i \in \{1, \dots, n\}}$ where $C_i: X \rightarrow \mathcal{D}$ a fuzzy partition, if $\bigcup_{x \in X} C_i(x) = D$ and for all $x \in X$, we have: $C_i(x) \in \alpha(x)$ and $C_i(x) \cap C_j(x) = \emptyset$ where $i \neq j$. We define fuzzy cluster as a fuzzy value $C_i(\xi)$ on the set $\mathcal{D}$, generated by canonical fuzzy element ξ of possibility space $(X, 2^X, P)$.

We propose evaluating methods for basic theoretical-possibility characteristics -possibility and necessity—for assertions regarding appoint belonging to the fuzzy cluster, fuzzy cluster and certain set non-empty intersection, and two points' equivalence relatively to fuzzy partition.

Problems of choosing the best (in certain sense) points and pairs of equivalent points of given data set are also considered in our paper.

References

1. Yu. Pytiev, Possibility. Elements of theory and applications, Moscow, URSS Edytoryal, 2000.

A DECISION TREE BUILDING USING RANK STATISTICS

Khytryi I.V.

Taras Shevchenko National University of Kyiv, Ukraine

hitry_igor@ukr.net

Let's denote that observation of a scalar variable y occurs under condition $x = (x_1, \dots, x_n)$. However, y is stochastic. According to sample data one must find areas of vector x values, where values of y are homogeneous. This result can be used for further sample analysis or for prediction.

A decision tree building using a statistical test of homogeneity is a suitable way to find homogeneous areas. Decision tree building procedure is a recursive split of the sample according to the rule which looks like $x_j < v$ so that p-value of homogeneity hypothesis applied to values y of two resulting subsamples is the smallest. The split occurs if it is statistically consistent. Rules of that splits that occurred form a decision tree.

The usage of a statistical test in a decision tree building helps to avoid the overfitting problem, which must be solved, when, for example, some entropy-based measures are used [1].

Until one doesn't make any assumptions about the distribution functions, nonparametric tests of homogeneity should be used.

In the context of the research there was implemented the software which allows to build decision trees using Wilcoxon-Mann-Whitney and Van der Waerden rank tests of homogeneity [2].

References

1. Hastie, T., Tibshirani, R., Friedman, J. H. The elements of statistical learning: Data mining, inference, and prediction. New York: Springer Verlag, 2001.
2. Van der Waerden, B.L. "Mathematische Statistik", Springer, 1957.

ASYMPTOTIC DISSIPATIVITY OF THE RANDOM EVOLUTION WITH IMPULSE PERTURBATION

¹Kinash A.V., ²Chabanyuk Ya.M., ¹Khimka U.T.

¹National University "Lviv Polytechnic" , Ukraine

²Lviv state university of life safety, Ukraine

sunnygirl5@ukr.net

Consider the stochastic system with impulse perturbation given by the stochastic differential equation [1]

$$du^\varepsilon(t) = C(u^\varepsilon(t); x(t/\varepsilon^4))dt + \varepsilon d\eta^\varepsilon(t), u^\varepsilon(t) \in \mathbf{R}, \quad (1)$$

with impulse perturbation process $\eta^\varepsilon(t) = \int_0^t \eta^\varepsilon(ds; x(s/\varepsilon^2))$, where family of processes with independent increments determined by generators $\Gamma_u^\varepsilon(x)\varphi(u, \omega, x)$ and $\Gamma_\omega^\varepsilon(x)\varphi(u, \omega, x)$ [2].

The limiting evolution for (1) is a solution of the following equation

$$du(t) = a(u)dt + \sigma(u)dW(t), \quad (2)$$

where $W(t)$ - Wiener process and $a(u)$ has the representation

$$a(u) = \int_x C(u; x)\pi(dx). \text{ Limiting diffusion } \sigma(u)\sigma^*(u) = B(u), \text{ where}$$

$$B(u) = 2 \int_x b_1(x)\mathbf{R}_0 b_1(x)\pi(dx) + \int_x b_2(x)\pi(dx) [2].$$

Let also satisfied the condition of balance $\int_x b_1(x)\pi(dx) \equiv 0$.

Definition. System (1) is called asymptotically dissipative if it is dissipative limiting evolution (2).

Theorem Let process $(u^\varepsilon(t), \eta^\varepsilon(t))$ satisfied weakly convergence conditions. In addition, for $c_1 > 0, c_2 > 0$ conditions $a(u)V'(u) < -c_1 V(u)$, $\sup_u \|\sigma(u)\| < c_2$ and condition of balance are satisfied.

Then the system (1) is asymptotically dissipative.

References

1. Кінаш А.В. Асимптотична дисипативність дифузійного процесу. / А.В. Кінаш, Я.М. Чабанюк, У.Т. Хімка // XXIII International Conference «Problems of Decision Making Under Uncertainties». Abstracts. - May12-16, - 2014, - Мукачево, Україна. – С.115– 116.
2. Korolyuk V.S. Stochastic Systems in Merging Phase Space/ Korolyuk V.S., Limnios N. – :World Scientific Publishing, – 2005. – 330 p.

THE NEW INVERSE BURGERS DYNAMICAL SYSTEM AND ITS INTEGRAL SUBMANIFOLD

Kindyaliuk A.A., Prytula M.M.

Ivan Franko National University of Lviv, Ukraine

mykola.prytula@gmail.com

Recently the inverse Burgers dynamical system for the Burger's equation $u_t + uu_x = u_{xx}$ was introduced in [2] in the next form:

$$\begin{cases} u_t = v, \\ v_t = u_x + uv. \end{cases} \quad (1)$$

We have obtained different inverse Burgers system in next form:

$$\begin{cases} u_t = v + \frac{1}{2}u^2 \\ v_t = u_x. \end{cases} \quad (2)$$

The main goal of system (2) is ability to rewrite it as a set of differential forms generating the closed Cartane-integrable ideal [1].

Theorem. *The set of first order equations (2) is equivalent to the set of second rank differential forms $\{\alpha^{(2)}\}$ constructing integral submanifold:*

$$\begin{cases} \alpha_1^{(2)} := du \wedge dx + vdx \wedge dt + (u^2/2)(dx \wedge dt), \\ \alpha_2^{(2)} := du \wedge dt + dv \wedge dx, \end{cases} \quad (3)$$

$$\text{Ideal is closed } dI(\alpha) \subset I(\alpha) : \begin{cases} d\alpha_1^{(2)} := (dx - dt) \wedge \alpha_2^{(2)}, \\ d\alpha_2^{(2)} := 0. \end{cases}$$

References

1. *Hentosh O.* Differential-geometric and Lie-algebraic foundations of investigating nonlinear dynamical systems on a function manifolds. The second edition. / *O. Hentosh, M. Prytula, A. Prykarpatsky* // L'viv University Publ., L'viv, Ukraine, 2006. (in Ukrainian).
2. *Prytula M.M.* Application of the methods of computer algebra for finding the conservation laws of nonlinear inverse Burgers dynamical system/ *M.M. Prytula, O.M. Dmukhovska* //Conference Applications of numerical techniques, mathematical modeling and mathematical methods in science research.// Lviv, 1994, p. 66 – 67. (in Ukrainian).

NONSTATIONARY TEMPERATURE FIELDS IN MEDIUMS WITH THE DYNAMIC CHARACTERISTICS

¹Kolyada Yu.E., ²Bulanchuk O.N.

¹Mariupol State University, Ukraine

²Pryazovskyi State Technical University, Ukraine

yukol@ukr.net

The study of nonstationary temperature fields in various mediums are necessary for understanding processes taking place in the modification of surface metals and alloys properties by pulsed concentrated energy flows. An operational property of machined details and components are substantially increased due to the formation the hardened surface layer as a result of modification. The hardened layer is formed with increased microhardness due to its heating and subsequent rapid cooling deep into the sample at a speed of 10^6 - 10^7 deg / s.

Experimental results of numerous authors indicate that a change in microhardness along the depth of the layer is a function with obviously expressed maximum. Such dependence is favorable from the viewpoint of operational characteristics detail subjected to friction. However, the available theoretical studies give different results- dependence of the microhardness of the depth hardened layer is a decreasing function with a maximum value at the sample surface, which passes to the microhardness of the original material. I.e. there is an obvious discrepancy between the experimental and theoretical results. Such calculations are obtained by many authors for solving one-dimensional heat equation. It was assumed that the thermodynamic characteristics of the medium remained stationary.

In this work we solve the problem of the spread the temperature field in medium with dynamic characteristics. In particular, the phase transformations have been considered occurring in the medium (in the metal), under the action of the pulsed surface energy flows. It is these circumstances lead to the necessity take into account dynamics of the basic thermodynamic properties of mediums in different phases (solid - liquid). Consideration was also given the energy loss due to thermal radiation.

The simplest way to model the heat transfer process in view melting of the medium is use a classical heat equation with the modified density, specific heat and thermal conductivity coefficient:

$$\rho^c p \frac{\partial T}{\partial t} = \frac{\partial}{\partial x} \left(k \frac{\partial T}{\partial x} \right).$$

Here, the coefficient heat conductivity of a medium k is calculated using the formula $k = (1 - \alpha)k_1 + \alpha k_2$, subscripts 1 and 2 denote the coefficients relating to the of heat conductivity of the liquid and solid; α - smoothing function, which depends on the temperature T and simulating phase state of medium. View $\alpha(T)$ is given from the assumption, that the phase transition is carried out in the temperature range from $T_{pc} - \Delta T / 2$ to $T_{pc} + \Delta T / 2$, where T_{pc} - the melting temperature, ΔT - the width of the temperature interval inside which the substance is a mixture of solid and the melt. In this case $\alpha(T)$ defined in such a way that it is equal to one, if the substance is a liquid and zero, when-solid:

$$\alpha(T) = \begin{cases} 0, & T \leq T_{pc} - \Delta T / 2 \\ 1, & T \geq T_{pc} + \Delta T / 2 \end{cases}, \text{ with following}$$

condition $\int_{T_{pc} - \Delta T / 2}^{T_{pc} + \Delta T / 2} \frac{d\alpha(T)}{dT} dT = 1$. In the case of infinitely narrow interval

function $\alpha(T)$ is the Heaviside function equal to zero then $T < T_{pc}$

and equal to one for $T > T_{pc}$, here $\frac{d\alpha}{dT}$ - Dirac function.

For the specific heat capacity at constant pressure, also temperature-dependent, formula is used

$$c_p = (1 - \alpha)c_{p,1} + \alpha c_{p,2} + \lambda \frac{d\alpha}{dT},$$

where λ specific heat of fusion. Density of the material as a function of temperature, given by expression

$$\rho = \frac{(1 - \alpha)\rho_1 c_{p,1} + \alpha \rho_2 c_{p,2}}{(1 - \alpha)c_{p,1} + \alpha c_{p,2}}.$$

It is investigated model yielded nature of the change microhardness into the sample, which is observed experimentally. All this has allowed better understand the essence the physical processes occurring in the interaction of concentrated energy flows with medium and take the necessary technical decision by consideration of concrete problems.

PROBABILISTIC APPROACH TO CONSTRUCTION OF MODELS OF DUOPOLY WITH QUADRATIC FUNCTIONS OF COSTS OF PRODUCERS

Kosarevych K.V.

Ivan Franko National University of Lviv, Ukraine

katia_kosarevych@mail.ru

Two nonclassical models of the quantitative competition under the conditions of duopoly with random strategies and quadratic costs of producers were proposed. The class of distributions of random quantities of manufacturer's production, which guarantees the existence of "corrected" Nash equilibrium [1] in built models, was allocated. Formulas for the calculation of the equilibrium were found in an explicit form, first in case of duopoly with one random strategy [2], later with both random strategies.

In particular, all results were obtained for exponential and uniform distributions of random strategies with changeable parameters of distributions. Herewith the quantities of manufacturer's production are considered independent random variables. The use of exponential and uniform distributions (with changeable parameters) allows to solve the problem of searching of "corrected" Nash equilibrium by the methods of convex optimization.

References

1. Косареви́ч К. В. “Виправлена” рівновага за Нешом у грі з випадковими стратегіями для класу квадратичних функцій витрат / К. В. Косареви́ч // XXIII International Conference "Problems of decision making under uncertainties" (PDMU-2014): Abstracts, May 12-16, 2014, Mukachevo, Ukraine. – К.: 2014. – С. 117.
2. Косареви́ч К. В. Про існування та форму “виправленої” рівноваги за Нешом у грі з випадковими стратегіями для класу квадратичних функцій витрат / К.В. Косареви́ч // «Сучасні проблеми математичного моделювання, прогнозування та оптимізації: тези доповідей VI міжнародної конференції – Кам’янець-Подільський, квітень, 2014. – С. 86-87.

ASYMPTOTIC GENERATOR OF OPTIMIZATION PROCEDURE WITH IMPULSIVE PERTURBATIONS

¹Kukurba V., ²Chabanyuk Ya., ³Malanchuk O.

¹National University Lviv Polytechnic, Ukraine

²Lviv State University of Life Safety, Ukraine

³Lviv National Medical University, Ukraine

vkuku@i.ua

Continuous stochastic optimization procedure with semi-Markov's switchings and impulsive perturbations is defined by the evolution equation[1]:

$$du^\varepsilon(t) = a(t)[\nabla_{b(t)}C(u^\varepsilon(t); x(t/\varepsilon^4))dt + \varepsilon d\eta^\varepsilon(t)], \quad (1)$$

where $\nabla_{b(t)}C(u; x) = \frac{(C(u + b(t); x) - C(u - b(t); x))}{2b(t)}$, $u \in R$. The

regression function $C(u; x)$ depends on uniformly ergodic semi-Markov process $x(t) > 0, t \geq 0$, in the dimensional space phase of states $(X, \mathbf{X})$, $u^\varepsilon(t), t \geq 0$ – random evolution, ε - scheme parameter. Impulsive perturbation process $\eta^\varepsilon(t), t \geq 0$ and its generator are defined in [2].

Lemma. Generator of procedure (1) on perturbed Lyapunov function $V^\varepsilon(u; x, t) = V(u) + \varepsilon^3 a(t)V_1(u; x) + \varepsilon^4 a(t)V_2(u; x)$, where $V(u) \in C^4(R)$, has representation:

$$\mathbf{L}_{t,0}^\varepsilon V^\varepsilon(u, x, t) = a(t)\mathbf{L}V(u) + \varepsilon \theta_0^\varepsilon(t)V(u),$$

where $\mathbf{L}V(u) = \Pi C_b(x)V(u) = \Pi \nabla_b C(u; x)V'(u)$. The negligible term $\theta_0^\varepsilon(t)V(u)$, satisfies condition $|\theta_0^\varepsilon(t)V(u)| \leq M$.

References

- 1 Kukurba V. Stochastic optimization with semi-Markov switching and impulsive perturbation. / Kukurba V // Mathematic and Computing Modeling Kamenetz-Podolsk National University – 2013. — №. 8. – P. 112-121.
2. Semenyuk S. Stochastic evolution systems with impulsive perturbation / Semenyuk S., Chabanyuk Ya. // Physics and Mathematics — Lviv. : National University Lviv Polytechnic – 2009 № 660, — 56–60 p.

MARKOV MODEL HEALTH INSURANCE POLICES

Kushnir I., Yeleyko Ya.

Ivan Franko National University of Lviv, Ukraine

kushnir.iruna@gmail.com

To describe the policy should specify: validity of the policy T , the set of possible states of the insured E and stochastic process $\xi(t)$ on T with values of E , reflecting the random change of state of the insured [1].

We denote by Z , $Z = e^{-\delta t}$ the random variable describing the insurance benefits, when the insured event. Let δ – continuous random variable with distribution function $F(x)$, which describes the interest rate. Then the actuarial present value for the insured aged n years from payment of the size of the unit at the time of the insured event can calculate as follows:

$$\bar{A}_n = E[Z] = \int_0^n p_x(t) \left(\int_0^\infty e^{-\delta t} dF(\delta) \right) dt. \quad (1)$$

If δ – random variable that takes the value of $\delta_1, \delta_2, \dots, \delta_k$ with probabilities $p_1, p_2, \dots, p_k$, respectively. Then the actuarial present value is calculated as:

$$\bar{A}_{x,n} = E[Z] = \sum_k p_k \int_0^n e^{-\delta_k t} p_x(t) dt, \quad (2)$$

where $p_x(t)$ is the probability of the insured event.

References

1. Cartashov M.V. Markov processes in actuarial mathematics: Textbook / M.V.Kartashov. – K. publishing center "Kyiv University", 2008 – 56 p.

STEADY STATE ANALYSIS OF INFINITE RETRIAL QUEUES

Lebedev Eugene, Ponomarov Vadym

Taras Shevchenko National University of Kyiv, Ukraine

vponomarov@gmail.com

Retrial queues are a very important class of stochastic systems that are often used in practice. The queuing systems are the most appropriate models for computer and telecommunication networks, queue control and other stochastic systems (for more details see [1]).

In classic retrial queues it is usually assumed that each call which cannot be served immediately and has joined to the orbit returns to the

servers and tries to get service again in a random period of time independently from other sources of retrial calls.

In spite of widespread of the retrial queues explicit formulas of the steady state probabilities were obtained only in the simplest cases [1]. Steady state distribution or main performance measures of queues with more than two servers are usually computed by some sort of a recurrent algorithm.

The main purpose of this presentation is to obtain explicit analytical expressions of probabilistic characteristics of the M/M/c/∞ queue in the steady state through its parameters for all $c=1,2,\dots$. First we obtain explicit formulas of vector-matrix type for steady state distribution of the truncated system. It can be written in the following form:

$$\pi_j(N) = \Delta_j(N) \cdot \pi_{00}(N), j = 0, 1, \dots,$$

$$\text{where } \Delta_j(N) = \left(\prod_{i=j}^{N-1} B_i^{-1} A_i \right) C^{-1} e_1 \left\{ e_1^T \left(\prod_{i=0}^{N-1} B_i^{-1} A_i \right) C^{-1} e_1 \right\}^{-1}, \quad A_i, B_i, C -$$

matrices that depend on the parameters of the system.

To find stationary distribution of the initial system we now take the limit of $\Delta_j(N)$ as truncation level N tends to infinity.

In case of the system with one or two servers, the above formulas turn into scalar expressions, which are well known from earlier works.

References

1. Falin G. I., Templeton J. G. C. Retrial queues. – London: Chapman & Hall, 1997.

TOPOLOGY OF HAMILTONIAN VECTOR FIELDS ON CLOSED DOMAIN

Losieva M., Pryshliak D.

Taras Shevchenko National University of Kyiv, Ukraine

mv.loseva@gmail.com

On the plane, we consider closed bounded domain U with smooth boundary. A function f is an m -function if all the critical points of the function f and its restriction to the boundary are nondegenerated. Hamiltonian vector generated by the function f , or skew gradient field of the function f has the integral curves, which coincide with the components of the function levels. To describe the topological structure of the this field we use graph introduced in the works Kronrod and Reeb, which is obtained as a quotient space of U by identification of the points belonging to the same component of level. Orientation graph is

determined by the direction of function increasing. Also we paint the edges in two colors – red, if the corresponding components of the level are homeomorphic to the segments, and black if they are homeomorphic to the circles.

A function will be called simple if function is not more than one critical point of the function or its restriction on each level. Two vector fields is called topologically equivalent if there exists a homeomorphism that maps the trajectory of one of the vector field in the trajectories of the other, keeping the direction of movement on them.

Theorem. *Two Hamiltonian vector fields of simple m -functions on compact domains are topologically equivalent if and only if their painted oriented Kronrod-Reeb graphs are isomorphic (isomorphism preserves the color and orientation of the edges).*

References

1. Кронрод А. С. О функциях двух переменных // Успехи мат. наук. - 1950. - Вып. 5(35). С. 24 - 134.
2. Reeb G. Sur les points singuliers de une forme de Pfaff completement integrable ou de une fonction numerique. // Comptes Rendus Hebdomadaires des Seances de Academie des Sciences. - 1954. - V. 222. - P. 847-849.

MINIMAX FILTERING PROBLEM FOR STOCHASTIC SEQUENCES WITH STATIONARY INCREMENTS

¹Luz M.M., ²Moklyachuk M.P.

Taras Shevchenko National University of Kyiv, Ukraine

¹maksim_luz@ukr.net, ²mmp@univ.kiev.ua

The problem of optimal mean-square estimation of a linear functional $A\xi = \sum_{k=0}^{\infty} a(k)\xi(-k)$ of unknown values of a stochastic sequence $\xi(m)$, $m \in Z$, with stationary n th increments [1] from observations $\xi(k) + \eta(k)$ at points of time $k = 0, -1, -2, \dots$, is considered. $\eta(m)$, $m \in Z$, is an uncorrelated with $\xi(m)$ stationary stochastic sequence. In the case where spectral densities $f(\lambda)$ and $g(\lambda)$ of the sequences are known spectral characteristic and mean-square error of an estimate $\hat{A}\xi$ are calculated by the formulas

$$h_{\mu}(\lambda) = \frac{g(\lambda) \sum_{k=0}^{\infty} a(k) e^{-i\lambda k}}{(-i\lambda)^n (f(\lambda) + \lambda^{2n} g(\lambda))} - \frac{(-i\lambda)^n \sum_{k=1}^{\infty} (P_{\mu}^{-1} S_{\mu} a_{\mu})_k e^{i\lambda k}}{(1 - e^{i\lambda \mu})^n (f(\lambda) + \lambda^{2n} g(\lambda))},$$

$$\Delta(f, g; \hat{A}\xi) = \langle S_{\mu} a_{\mu}, P_{\mu}^{-1} S_{\mu} a_{\mu} \rangle + \langle Qa, a \rangle.$$

The operators S_{μ} , P_{μ} , Q are defined by the Fourier coefficients of the functions $\frac{|1 - e^{i\lambda \mu}|^{-2n} \lambda^{2n} g(\lambda)}{f(\lambda) + \lambda^{2n} g(\lambda)}$, $\frac{|1 - e^{i\lambda \mu}|^{-2n} \lambda^{2n}}{f(\lambda) + \lambda^{2n} g(\lambda)}$, $\frac{f(\lambda) g(\lambda)}{f(\lambda) + \lambda^{2n} g(\lambda)}$; the vectors a_{μ} and a are defined by the coefficients $a(k)$, $k = 0, 1, 2, \dots$.

Minimax method of estimation is applied in the case where spectral densities $f(\lambda)$ and $g(\lambda)$ of the sequences are not known, but sets of admissible spectral densities are given. Formulas that determine the least favorable spectral densities and minimax spectral characteristics are proposed for some special classes of admissible densities [2].

References

1. Yaglom A. M. Correlation theory of stationary and related random functions. Vol. 1: Basic results / Springer Series in Statistics, Springer-Verlag, New York etc., 1987. – 526 p.
2. Maksym Luz, Mikhail Moklyachuk. Minimax-robust filtering problem for stochastic sequences with stationary increments and cointegrated sequences // Statistics, Optimization & Information Computing. – 2014. – Vol. 2, No.3. – P. 176-199.

MODELING OF FUNDAMENTAL FACTORS ON THE DYNAMICS OF PRICES FOR REAL PROPERTY UNDER UNCERTAINTY

Maksyshko N., Shapovalova V.

Zaporizhzhya National University, Ukraine

maxishko@ukr.net, victoria2909@mail.ru

The real estate market is an integral part of the system of economic relations. The prediction of the of the real estate market behavior is particularly difficult due to the fact that the processes taking place in the market influenced by objective economic conditions and subjective decisions of market participants determine the nonlinear dynamics of market prices, the crisis and, as a result, a high degree of unpredictability dynamics.

In the face of uncertainty cognitive modeling is the unique tool for the analysis, the use of which is appropriate for the analysis of the functioning of the real estate market.

In this paper presents the cognitive model that reflects the impact of fundamentals on changing the dynamics of the price of real estate. For its construction analyzes four main factors: natural (floods, hurricanes, volcanic eruptions, and other emergencies, etc.), economic (crisis and economic growth as a result of which there are changes in GDP, revenues and costs of economic agents and inflation), political (change leadership of the country: the election of presidents, governments and parliaments, acceptance of bills, etc.), social unrest or more.

The result is a cognitive model quantitative measurement validity of fundamental factors on the dynamics of prices for real estate, represented as a vector $\varphi = (\varphi_1^\Delta, \varphi_2^\Delta, \varphi_3^\Delta, \varphi_4^\Delta)$.

The cognitive models of accounting for the influence of fundamental factors on the dynamics of real estate prices makes it possible to increase the effectiveness of decisions made in real estate, and used to build an effective prediction system.

APPLICATION OF THE AGENT-BASED MODELING APPROACH TO DECISION MAKING

Manovytska D.

Taras Shevchenko National University of Kyiv, Ukraine

manovytska_dariia@ukr.net

Strengthening of real processes unpredictability in society calls for the need for creating new analytical approaches and related management methods.

The paper describes procedures that could increase the effectiveness of managerial decision-making at the regional and state levels by deepening our understanding of the meaning of complex unexplained phenomena in society, influences of preferences for one's own kind, that can lead either to conflict or to cooperation. For that, in the paper Schelling Segregation Model [2] and simulation software tool NetLogo [1] are used.

Schelling segregation model is designed to explore important social phenomena and it represents a system of dynamically interacting agents, "the model of self-assembled Neighborhood". Schelling introduced a model system of distinguishable types of agents (population, folks) with discriminatory individual preferences for certain neighborhood

compositions, and then quantitatively explored the dynamics of this model system. Schelling model showed that spontaneous human interactions often lead to the emergence of an unintentional patterns on a societal level, either desirable or not; it explained why do wars start, conflicts between people, nations emerge, etc. Especially interesting are segregation patterns resulting from the voluntary choices of individuals, when rigid segregation is the unintended consequence of a much milder preferences (the paradox of "weak preferences"). In some cases, due to the small incentives, the actions of blind forces - seemingly harmless personal preferences, can lead to polar results. Using this model, we can find that when the desired similarity threshold is too high (90%), then in such a society will never be peace. At 40% similarity, there are segregated areas like the ghetto areas of racial segregation.

Using Schelling Segregation Model and results obtained in NetLogo in managerial procedures allows enhancing the quality of decisions taken.

References

1. Wilensky, U. (1997, 1999). NetLogo.
<http://ccl.northwestern.edu/netlogo/models/Segregation>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.
2. Schelling, T. Micromotives and Macrobehavior. New York: Norton, 1978.

INVESTIGATION OF NONLINEAR DYNAMICS IN MODEL OF HODGKIN-HUXLEY BASED ON LYAPUNOV'S EXPONENT

Marcenyuk VP, Maihruk ZV

Ya. Horbachevsky Ternopil State Medical University, Ukraine
marceniuk@yahoo.com, zorana_mauhruk2010@mail.ru

Software implementation of the algorithm for calculating the Lyapunov exponent.

The software environment proposed in this paper is implemented as package of Java-classes. It consists of the following packages and classes.

FDE package is designed to obtain the numerical solution of differential equations. GRAPH package contains classes for graphical visualization of solutions of equations. Hodgkin_huxley package contains classes describing the Hodgkin-Huxley model and algorithm for calculating the Lyapunov exponent. This package includes the following classes:

- `Hodgkin_HuxleyLiapunovExponentsSystem` – describes the right parts of the differential equations of Hodgkin-Huxley model and algorithm for calculating the Lyapunov exponent;
- `Hodgkin_HuxleyLiapunovExponentsSystemGraph` – is used for graphical plotting of solutions of equations;
- `Hodgkin_HuxleyLiapunovExponentsSystemGraphMenu` – class, which describes the main menu of a program;
- `Hodgkin_HuxleyLiapunovExponentsSystemInputDataFrame` – class-frame for input of initial parameters of a model.

The developed software package of classes is a useful tool that can be used in web projects of integrated physiological modeling.

References

1. Hodgkin L. and Huxley A. F., A quantitative description of membrane current and its applications to conduction and excitation in nerve, *J. Physiol. (Lond.)*, 116 (1952), pp. 500–544.
2. Hassard B., Bifurcation of periodic solutions of the Hodgkin-Huxley model for the squid giant axon, *J. Theoret. Biol.*, 71 (1978), pp. 401–420.
3. Fukai H., Nomura T., Doi S., and Sato S., Hopf bifurcations in multiple-parameter space of the Hodgkin-Huxley equations, I, II, *Biol. Cybern.*, 82 (2000), pp. 215–222; 223–229.
4. Guckenheimer J. and Labouriau I. S., Bifurcation of the Hodgkin–Huxley equations: A new twist, *Bull. Math. Biol.*, 55 (1993), pp. 937–952.
5. Майхрук З.В. Програмна реалізація чисельного методу оптимального керування біфуркацією в моделі Ходжкіна-Хакслі. / Майхрук З. // Вісник Хмельницького національного університету №1, 2014р. – С.186-194.
6. Марценюк В.П. Майхрук З.В. Побудова оптимального керування біфуркацією в моделі Ходжкіна-Хакслі на основі принципу максимуму. / Марценюк В.П. Майхрук З. // Науковий журнал інституту кібернетики імені В. М. Глушкова Національної академії наук України Кам'янець-Подільський національний університет імені Івана Огієнка Математичне та комп'ютерне моделювання Серія: Технічні науки №9, 2014р. – С.78- 90.

ABOUT ONE ALGORITHM CLUSTERING DATABASES IN ELECTRONIC COMMERCE

Marin D.E.

Taras Shevchenko National University of Kyiv, Ukraine

dimam1391@gmail.com

The general idea of the algorithm is to construct neural network training unmanageable. It consists in calculating the geometric properties Hebbopodobnoho rule learning and lateral interactions.

The main characteristics of the algorithm are:

- continuous input space images activations generated from some probability distribution;
- the network topology is built in the shape of a lattice consisting of neurons determines the discrete output space;
- neighborhood function $h_{j,i(x)}(n)$ is time-dependent and is defined in a neighborhood of the winning neuron $i(x)$;
- learning speed setting $\eta(x)$, for any given initial value η_0 , gradually decreasing in time n , but does not reach zero.

Apart from initialization, the algorithm goes through three basic steps: sub-sample, find best match and adjusting.

1.*Initialization.* For outgoing vectors of synaptic weights $W_{j(0)}$ are selected random values. The only requirement here is the difference vectors for different values of $j = 1, 2, \dots, l$, where l - the total number of neurons in the lattice. It is recommended to keep small amplitude values. Another way to initialize the algorithm is the random selection of the set of weights $\{W_{j(0)}\}_{j=1}^l$ with the available set of input vectors.

2.*Subsample.* Choosing the vector x from the input space with a certain probability. This vector is the excitement that is applied to the lattice of neurons. The dimension of the vector x is equal to m .

3.*Find the maximum similarity.* Find the most suitable (who won) neuron $i(x)$ at step n , using the criterion of minimum euclidean distance:
$$i(x) = \arg \min_j \|x - w_j\|, j = 1, 2, \dots, l$$

4.*Correction.* Corrects vectors synaptic weights of all neurons using the following formula: $w_j(n+1) = w_j(n) + \eta(n)h_{j,i(x)}(n)(x - w_j(n))$ where $\eta(T)$ - setting speed training; $h_{j,i(x)}(n)$ - neighborhood function

centered on the winning neuron $i(x)$. Both of these parameters are changed dynamically during training in order to obtain better results.

5. *Continued.* Go back to step 2 and continue the computation as long as the card features do not stop to significant changes occur.

This algorithm was used in e-commerce to increase the number of sales.

References

1. Хайкин С. Нейронные сети. Полный курс / С. Хайкин — М.: Вильямс, 2006 — 1104 с. — ISBN5-8459-0890-6.

SOFTWARE ENVIRONMENT OF EPIDEMIOLOGICAL SYSTEM RESEARCH

Marcenyuk V., Kuchvara O.

I.Y. Horbachevsky Ternopil State Medical University, Ukraine

marceniuk@yahoo.com , koleksandra@i.ua

Influenza and infectious diseases continue to be one of the most urgent medical and social problems. Advanced researches in analyses and authentic scenarios of epidemic growth forecast are of particular importance nowadays. The prediction of arising and course of epidemics is necessary for the most effective implementation of immunoprophylaxis measures, in particular, it is significant both for elucidation and organizing planning of events.

The purpose of this report is to suggest web-integrated software environment that implements principle mathematical models on the basis of approaches to computer modeling and also on the basis of existing software which is used during epidemiological investigations.

The results of system analysis in the process of decision making in epidemiological system investigations, the analyses of system structure and project investigations, allow to design and to realize the software for mathematical epidemiology tasks. SSMD uses modern algorithms of data processing and contains databases for input, eternal and imprint data flows and knowledge base that give an opportunity to assess impartially the condition of the epidemiological disease extension process and to choose optimal decisions concerning the prophylaxis and treatment. The use of client-server architecture allows providing an effective access to data, realizing security measures and heightening the effectiveness of information processing.

The Netbeans environment is chosen as a set of instruments for Java-project of this paper – by virtue of characteristics of universality, quickness of developing and openness which are described above. More-

over, freely distributed libraries of AJAX and RIA components are used in the project – both for work with database and for graphic interface.

Consequently, the software environment of epidemiological system researches, is suggested in this paper. The project is realized on the basis of Java-technologies, which makes this program product to be Web-integrated.

Software environment secures the threshold values calculation of reproduction basic numbers, taking into consideration the type of compartmental epidemiological model and also optimal diagram of prophylactic measures.

References

1. Наконечный А.Г., Модели популяционной динамики в задачах математической эпидемиологии острых респираторных заболеваний. / А.Г.Наконечный, В.П. Марценюк, А.М. Кучвара // Кибернетика и вычислительная техника. – 2010, Вып.159. – С.45–64.
2. Марценюк В.П., Задача оптимальної вакцинації в моделі співіснування двох штамів вірусу/ В.П. Марценюк, А.М. Кучвара // Наукові праці – 2014, Вип.217, Т229. – С. 58–67.
3. Martsenyuk, Vasily P. On Conditions of Asymptotic Stability in SIR-Models of Mathematical Epidemiology/ Vasily P Martsenyuk, , Igor E.Andrushchak, Alexandra M. Kuchvara , // Journal of Automation and Information Sciences. – 2011,VO 43. – P.59–68.

A MATHEMATICAL PROGRAMMING PROBLEM WITH THE FUZZY SET OF CONSTRAINTS

Mashchenko S.O., Al-Sammarraie Mohammed Saad Ibrahim

Taras Shevchenko National University of Kyiv, Ukraine

msomail@yandex.ua, blackhawk_is@yahoo.com

A classical problem statement in mathematical programming is to search an extremum of objective function $g(x)$ on a set F of feasible alternatives x being elements of a set X . The set of feasible alternatives F is specified on X by a set $M = \{1, 2, \dots, m\}$ of inequality constraints of the form $f_i(x) \leq 0$, $i \in M$.

In known formulations of fuzzy mathematical programming problems the fuzziness is manifested in the description of both the objective function and the set of alternatives, not concerning the set of constraints. In the report, we will analyze a mathematical programming problem with a fuzzy set of the indices of constraints.

Assume that decision maker (DM) cannot clearly specify which

constraints from the set M should actually define the feasible alternatives but can only define a membership function $\mu(i)$, $i \in M$, of the fuzzy set of indices $\tilde{M} \subseteq M$ of actual (in his opinion) constraints. Without loss of generality, we assume that the DM maximizes the objective function. Then a mathematical programming problem with a fuzzy set of the indices of constraints occurs in the following formulation: $g(x) \rightarrow \max, x \in X, f_i(x) \leq 0, i \in \tilde{M}$.

In the basis of offered approach the notion of intersection of fuzzy set of fuzzy sets [1] lies to the solving of this problem. In the report properties of this set are led and the formulation of the problem of rational decisions choice is considered.

References

1. Mashchenko S.O. A mathematical programming problem with the fuzzy set of indices of constraints / S.O. Mashchenko // Cybernetics and systems analysis. – 2013. – 49. – N 1. – P. 62 – 68.

TO THE ISSUE OF SOLUTION ESTIMATING OF LINEAR VARIATIONAL EQUATIONS IN GILBERT SPACES UNDER UNCERTAINTIES

Nakonechnyi¹ O., Kotsur M., Kapustian O.²

Taras Shevchenko National University of Kyiv, Ukraine

¹a.nakonechniy@gmail.com, ²olena.kap@gmail.com

Let H_0 be a Gilbert space over the field of real numbers, which coincides with its adjoint one, H_+ be a subspace of the space H_0 , which is continuously and densely embedded in H_0 . Let a vector $\varphi \in H_+$ be a solution of variational equation

$$a(\varphi, \psi) = (B\mathcal{G}, \psi) + (g, \psi), \quad \forall \psi \in H_+, \quad (1)$$

$a(\varphi, \psi)$ is a bilinear continuous form, given on H_+ , $B \in \mathcal{L}(H_1, H_0)$, $\mathcal{G}$ is a vector from Gilbert space H_1 , which is a solution of linear equation

$$F\mathcal{G} = f, \quad (2)$$

$F \in \mathcal{L}(H_1, H_2)$, H_1, H_2 are Gilbert spaces, f is some vector from domain of values of the operator F .

Assume that a vector y is given in form

$$y = C\varphi + v, \quad C \in \mathcal{L}(H_0, H), \quad (3)$$

where φ is the solution of the equation (1) with unknown value of f , v is unknown vector from Gilbert space H .

Under such a condition that (v, f) belongs to a set G of space $H \times H_2$, and perhaps the operator F has no the inverse one, we investigate the problems of finding optimal in some sense solution of equation (1) with the observations (3). Also we research the case when v is the realization of random vector with unknown correlation operator, which belongs to some set. Under some conditions on the sets, we prove that the optimal estimates satisfy some equations.

LINEAR ESTIMATES OF THE STOCHASTIC PROCESSES MEAN VALUES UNDER UNCERTAINTIES

Nakonechnyi O., Demydenko S.

Taras Shevchenko National University of Kyiv, Ukraine

a.nakonechniy@gmail.com

Let on interval $[0, T]$ a continuous in mean square vector stochastic process $\zeta(t)$ be given with mean value $E\zeta(t) = H(t)x(t)$ and correlation function $R(t, s)$, where $H(t)$ is a matrix of dimension $n \times m$, which has continuous elements and the continuous vector function $x(t)$ on $[0, T]$. We also assume that the values

$\eta_k = \int_0^{T_0} g_k(t)\zeta(t)dt, k = \overline{1, N}$, and realizations $\zeta(t)$ are observed on

the interval $[T_0, T]$ with known function $H(t)$ and unknown $x(t)$ and $R(t, s)$, which belong to the sets G and V of some functional spaces. $g_k(t)$ is the matrix functions sequence of dimension $p \times n$ with the elements from space $L_2(0, T_0)$. The linear estimates of the vector-

function $x(t)$ have a form $\hat{x}(t) = \sum_{k=1}^N u_k^{(1)}(t)\eta_k + \int_{T_0}^{T_1} u^{(2)}(t, s)\zeta(s)ds + c$,

where $u_k^{(1)}(t), u^{(2)}(t, s)$ are some matrix functions, c is vector.

Optimal estimate is found from the condition

$$\inf_{\hat{x}} \sup_{G, V} \int_0^T E |x(t) - \hat{x}(t)|^2 dt = \sup_{G, V} \int_0^T E |x(t) - \hat{x}(t)|^2 dt.$$

We prove the existence conditions for such estimates and investigate the problems of determining the best estimates for the sets

$$G = \left\{ x(\cdot) : \int_0^T \left| \frac{d^k x(t)}{dt^k} \right|^2 dt \leq q_1^2, k \geq 1 \right\}, \quad V = \left\{ R : \int_0^T spR(t, t) dt \leq q_2^2, k \geq 1 \right\}.$$

RISK MANAGEMENT AND DECISION SUPPORT IN INSURANCE

Norkin B.

Glushkov Institute of Cybernetics, Kyiv, Ukraine

bogdan.norkin@gmail.com

We study a stochastic bi-criteria optimal control problem to find an insurance company's optimal dividend policy accounting for return and risk indicators. The evolution of the company's capital is modeled by a stochastic risk process in discrete time with subtraction of dividends. As a measure of profitability average total discounted dividends are used, and as an indicator of risk, borrowed capital necessary to prevent ruin, as well as the probability of negative capital values is taken. We consider three approaches to solve the problem.

The first one is based on parallel simulation technique [1].

In the second one the problem is reduced to a one-criterion formulation by using penalty risk functions with variable penalty coefficient [2]. To find the optimal control the dynamic programming method is validated. Bellman optimality equations are solved by successive approximations that in this case have an exponential rate of uniform convergence.

In the third approach we approximate the Pareto optimal set of the problem by means of the so-called barrier-proportional control strategies [3]. In these strategies dividends are taken as a certain quota of the capital excess over given barrier. To find corresponding profitability and risk performance indicators we solve Bellman type integral equations.

References

1. Norkin B.V. Systems simulation analysis and optimization of insurance business // Cybernet. Systems Anal. – Vol. 50. – 2014. – No. 2. – P. 260-270.
2. Norkin B.V. On discrete time optimal control of risk processes // J. Automat. Inf. Scien. – Vol. 46. – 2014. – Issue 5.

THE MATHEMATICAL MODEL OF FORMATION AN ADMINISTRATIVE DECISIONS OF PROVIDING AN EDUCATIONAL SERVICES IN EDUCATIONAL INSTITUTIONS

Pampuha Igor, Savkov Pavlo, Savkova Valentina

pamp@ukr.net, savkovpa@meta.ua valentina.savkova@gmail.com

An existing world of the management tasks system of decision-making in the field of assessing the quality of educational services in higher education requires: high reliability; systematization of data and knowledge in related fields; genesis and predicting the results of the processes behavior; adapt to internal changes in the system, and external influences; optimized bench-mark data (input parameters, flexible mathematical data processing apparatus); grounding and a selection of the criterions for decision-making; consideration of the results of a professional activity; versatility of using . The analysis shows that the qualitative generalization and implementation of all of the above requirements is the development of an adequate mathematical model. One the aspect of its construction, it is a choice and justification of mathematical apparatus.

As the mathematical apparatus it is proposed to use synthesis of aggregate of theory of neural networks (non-linearity, mapping input data into output, adaptability, the obviousness of an answer, contextual information, fault tolerance, an efficient feasibility on modern computers and VLSI, the analogy with neurobiology), control theory (dynamic units to use as activation functions), analytic hierarchy process (the grounding of the choice of transfer functions and their parameters at every stage of the educational process description), space method (building of the dynamic model of the process of educational services with the ability to monitor the parameters in the defined check point and moment of a time, to explore reachability properties, controllability, stabilizability, observability, recoverability, identifiability, canonical decomposition, self-organization) benefits. Thus, as a result of the synthesis of mathematical tools it is possible to develop a mathematical model of describing the formation of administrative decisions on the provision of educational services in educational institutions to achieve quality at a level not lower than defined.

References

1. Neural networks: a complete course, 2nd edition. Russ. from English. – M.: Publishing House "Williams", 2008. – 1104p.: Il. - Parallel. tit. Engl.
2. Streits B. Method of state space theory of discrete linear control systems. / Per. from English. Ed. Y.Z. Tsyphina. - Moscow: Nauka. Home Edition physical and mathematical literature, 1985. – 296 p.

SIMULATIONS OF FRACTIONAL BROWNIAN MOTION

Pashko A.A.

Taras Shevchenko National University of Kyiv, Ukraine

pashkoua@mail.ru

Wiener process with arbitrary Hurst index can be represented as a series [1]

$$W_{\alpha}(t) = \sum_{k=1}^{\infty} (a_k \sin(x_k t) X_k + b_k (1 - \cos(y_k t)) Y_k),$$

where $\{X_k, Y_k\}$ - independent standard Gaussian random variables, $\{x_k\}$ - real zeros of Bessel functions $J_{1-\alpha}(x)$, $\{y_k\}$ - real zeros of Bessel

functions $J_{1-\alpha}(x)$, $a_k = \frac{\pi^{\alpha} \sqrt{2C}}{x_k^{\alpha+1} J_{1-\alpha}(x_k)}$, $b_k = \frac{\pi^{\alpha} \sqrt{2C}}{y_k^{\alpha+1} J_{-\alpha}(y_k)}$,

$C = \frac{\Gamma(2\alpha+1)\sin(\pi\alpha)}{\pi^{2\alpha+1}}$. Consider the following series as a model

$$S_{\alpha}(t, M) = \sum_{k=1}^M (a_k \sin(x_k t) X_k + b_k (1 - \cos(y_k t)) Y_k), \quad \text{where } \{X_k, Y_k\} -$$

independent strictly sub-Gaussian random variables. Since the zeros of Bessel functions are not exactly calculated, we will find them with some precision, the same applies to the expansion coefficients. Designate the approximate values a_k, b_k, x_k, y_k by $\tilde{a}_k, \tilde{b}_k, \tilde{x}_k, \tilde{y}_k$. Let $|a_k - \tilde{a}_k| \leq h_k^a$, $|b_k - \tilde{b}_k| \leq h_k^b$, $|x_k - \tilde{x}_k| \leq h_k^x$, $|y_k - \tilde{y}_k| \leq h_k^y$. Where $h_k^a, h_k^b, h_k^x, h_k^y$ accuracy of the calculation.

Then the process model has the form

$$\tilde{S}_{\alpha}(t, M) = \sum_{k=1}^M (\tilde{a}_k \sin(\tilde{x}_k t) X_k + \tilde{b}_k (1 - \cos(\tilde{y}_k t)) Y_k).$$

A simulation accuracy $\Delta(t)$ is equal to $\Delta(t) = W_{\alpha}(t) - \tilde{S}_{\alpha}(t, M)$.

Given results $\Delta(t)$ can be used to simulate processes with given accuracy and reliability in various function spaces.

References

1. Dzharaparidze K.O. A series expansion of fractional Brownian motion / K.O. Dzharaparidze, J.H. Zanten // CWI. Probability, Networks and Algorithms, R0216.

THE USE OF THE DCF MODEL IN ESTIMATING THE COST OF EQUITY CAPITAL IN VERTICALLY INTEGRATED COMPANY

PetlenkoYulia V.

Taras Shevchenko National University of Kyiv, Ukraine

f_knu_4@mail.ru

The main arguments that a vertically integrated company value is unaffected by its choice of capital structure was developed by J. B. Williams [1]. Following up on Williams' work, Modigliani–Miller (MM) [2] solved that all financing decisions are irrelevant. In this paper we discuss the use of a model based on the Discounted Cash Flow (DCF), or Gordon Model [3], approach to measuring equity costs. The general DCF model may be defined as follows:

$$value = P_0 = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \frac{D_3}{(1+r)^3} + \dots + \frac{D_\infty}{(1+r)^\infty}, \quad (1)$$

where P_0 is the current price of the stock of vertically integrated company, $0t$ is the expected periodic dividend, and r is the required rate of return.

Gordon and others went on to use the DCF model for many purposes, and versions were developed to deal with situations where the expected future growth rate is variable as well as constant. In almost all of the publications the intrinsic value of a firm is determined by the size, timing, and risk of its expected future dividend.

The basic DCF Gordon's Model constant growth model states that $r = \frac{D_1}{P_0} + g$, it is possible to rewrite the equation: $P_0 = \frac{D_1}{(r-g)}$,

where g expected growth rate in dividends as predicted by a marginal investor. In this sense, the constant growth assumption is a reasonable one for many vertically integrated companies.

The discounted- cash-flow (DCF) formula for the present value of a stock is just the same as it is for the present value of any other asset.

Recall that free cash flow (FCF) is the cash from operations that is actually available for distribution to investors, including stockholders, bondholders, and preferred stockholders. Therefore, vertically integrated company value can be calculated as the present value of its expected future free cash flows from operations, discounted at its weighted average cost of capital (WACC), plus the value of its nonoperation assets. This equation can be used to find the value of vertically integrated company's operations at time N, when its free cash flows stabilize and begin to grow at a constant rate.

$$value = \sum_{t=N+1}^{\infty} \frac{FCF_t}{(1+WACC)^{t-N}} = \frac{FCF_1}{WACC - g} = \frac{FCF_0(1+g)}{WACC - g}. \quad (2)$$

This result figure is called the company's terminal, or horizon, value, because it is the value at the end of the forecast period[4]. It is also sometimes called a continuing value.

References

1. Williams J.B. The Theory of Investment Value. - Cambridge, MA: Harvard University Press, 1938.
2. Modigliani F. and Miller M. H. The Cost of Capital, Corporation Finance and the Theory of Investment // *American Economic Review* 48 (June 1958), pp. 261–297.
3. Gordon M.J., Shapiro E. Capital Equipment Analysis: The Required Rate of Profit // *Management Science*. - October 1956, pp. 102 -110.
4. Brigham E, Erhardt M. Financial management: theory & practice. -South-Western: Cengage Learning, 2011.

ESTIMATES FOR THE MAXIMUS MODULUS OF ANALYTIC CHARACTERISTIC FUNCTIONS

Platsydem Marta, Sheremeta Myroslav, Kinash Orest

Ivan Franko National University of Lviv, Ukraine

marta0691@rambler.ru

Let F - distribution function. The function $\varphi(z) = \int_{-\infty}^{\infty} e^{izx} dF(x)$,

defined for real z [1, p. 12] is a characteristic function of this law.

If φ has the analytic continuation on the disk $D_R = \{z : |z| < R\}$, $0 < R \leq +\infty$, then we name φ by analytic in D_R . It is known that φ is analytic in D_R characteristic function if and only if for every $r \in [0, R)$ $W_F(x) = 1 - F(x) + F(-x) = O(e^{-rx})$, $x \rightarrow +\infty$.

By $\Phi \in \Omega(0, R)$, $0 < R < +\infty$, we denote the class of positive unbounded functions Φ on $[r_0, R)$ for some $r \in [0, R)$ such that the derivative Φ' is positive, continuously differentiable and increasing to $+\infty$ on (r_0, R) . For $\Phi \in \Omega(0, R)$, let $\Psi(r) = r - \frac{\Phi(r)}{\Phi'(r)}$ be the function associated with Φ in the sense of Newton and Φ^{-1} be the inverse function to Φ' .

For $\Phi \in \Omega(0, R)$, and $\Phi'(x_0) \leq a < b < +\infty$ we put

$$G_1(a, b, \Phi) = \frac{ab}{b-a} \int_a^b \frac{\Phi(\varphi(t))}{t^2} dt, \quad G_2(a, b, \Phi) = \Phi \left(\frac{1}{b-a} \int_a^b \varphi(t) dt \right).$$

Theorem Let $\Phi \in \Omega(0, R)$, $0 < R < +\infty$, and φ be an analytic in D_R characteristic function of a probability law F , which satisfies $\lim_{x \rightarrow +\infty} W_F(x) e^{Rx} = +\infty$. We suppose that $\ln \mu(r, \varphi) \leq \Phi(r)$ for all $r \in [r_0, R)$ and $\ln W_F(x_k) - \ln W_F(x_{k+1}) = O(1)$, $k \rightarrow \infty$, for some increasing to $+\infty$ sequence $X = (x_k)$ of positive numbers. Then

$$\lim_{r \uparrow R} \frac{\ln \mu(r, \varphi)}{\Phi(r)} \leq \lim_{k \rightarrow \infty} \frac{G_1(x_k, x_{k+1}, \Phi)}{G_2(x_k, x_{k+1}, \Phi)}$$

and if

$$Q(r) + \left(\frac{\Phi(r)\Phi''(r)}{(\Phi'(r))^2} - 1 \right) \ln \Phi(r) \geq q > -\infty, \quad r \in [r_0, R),$$

where $Q(r) \equiv 0$ if $R < +\infty$ and $Q(r) \equiv \ln r$ if $R = +\infty$, then

$$\lim_{r \uparrow R} \frac{\ln \ln \mu(r, \varphi)}{\ln \Phi(r)} \leq \lim_{k \rightarrow \infty} \frac{\ln G_1(x_k, x_{k+1}, \Phi)}{\ln G_2(x_k, x_{k+1}, \Phi)}.$$

References

1. Linnik Yu.V., Ostrovskii I.V. Decomposition of random variables and vectors. - Moscow: Nayka, 1971. - 479 p.

GUARANTEED ESTIMATES OF SOLUTIONS AND RIGHT-HAND SIDES OF INFINITE SYSTEMS OF LINEAR ALGEBRAIC EQUATIONS UNDER UNCERTAIN DATA

Podlipenko Yu. K.

Taras Shevchenko National University of Kyiv, Ukraine

youripl@mail.ru

In this study we focus on the problem of guaranteed estimation of solutions and right-hand sides of infinite systems of linear equations

$$x_i - \sum_{k=1}^{\infty} a_{ik} x_k = b_i, \quad (i = 1, 2, \dots) \quad (1)$$

under uncertainties. Here we suppose that a_{ik} are the known coefficients satisfying the condition

$$\sum_{i,k=1}^{\infty} a_{ik}^2 < \infty,$$

$b_i, i = 1, 2, \dots$, the free members, are unknown and subjected to a certain quadratic restriction. We also suppose that system (1) has a unique solution in the space l^2 for any $b = \{b_i\} \in l^2$ (this assumption is fulfilled if and only if when the number 1 is not an eigenvalue of the operator $A \in L(l^2)$ defined by the infinite matrix (a_{ik})).

From indirect noisy observations of unknown solution $x = \{x_i\} \in l^2$ of system (1) we obtain optimal, in certain sense, linear with respect to observations estimates of this solution and right-hand side $b = \{b_i\}$ and estimation errors which are expressed via solutions of some two uniquely solvable infinite systems of linear equations of special type.

It is proved that the solution of each of obtained systems may be found by the method of reduction, i.e., by means of a passage to the limit in the solution of the finite system obtained from the corresponding infinite system by discarding all equations and unknowns commencing with a certain one.

THE THRESHOLD CONTROL POLICY FOR RETRIAL QUEUES WITH TWO RETRIAL ATTEMPTS

Pryshchepa Oksana

Taras Shevchenko National University of Kyiv, Ukraine

`o.prischepa@gmail.com`

Retrial queues have been widely used to model the many real situations in telephone systems, telecommunication networks and call centers (see, for example, [1],[2]).

In this work we consider the $M/M/c$ retrial queues in which the number of retrials for each customer is limited by two attempts. These retrial queues are characterized by the following feature. A flow of customer arrives from outside to servers. If an arriving primary customer finds a server free then it immediately occupies the server and leaves the system after service. If all servers are busy then it leaves service area and some random time repeats his demand. If a customer fails to enter the service facility at second retrial then the customer leaves the system without service.

We consider situation when a rate of the input flow is controlled by the threshold policy. That is, if in some moment of time the total number of customers in the orbit of the system which can do first and second attempt does not exceed the value H then the system operates in the first mode with rate of input flow h_1 . If it is more than H then the system switches the second mode with rate of input flow h_2 .

The main purpose of the presentation is to point out the optimal threshold H depending on model parameters. For this purpose the algorithm for stationary probabilities and the quality function are constructed for the truncated model of our queue. That is, the orbit size (numbers of customers in the orbit of the system which can do first and second attempts) is limited by given two constants.

References

1. Artalejo J.R., Gómez-Corral A. Retrial Queueing Systems. A Computational Approach. - Springer, 2008.— 318 p.
2. Falin G. I. and Templeton J. G. C. Retrial queues. - London: Chapman and Hall, 1997. - 328 p.

CALIBRATED MEAN IN SAMPLING SURVEY

Rozora Iryna, Lukovych Olga

Taras Shevchenko National University of Kyiv, Ukraine

irozora@biigmir.net

Calibration weighting is a general technique for adjusting probability-sampling weights to increase the precision of estimates, account for unit nonresponse or frame errors, or force internal estimates to be consistent. Lets, however, focuses on the basic conditions: single phase sampling and full response. In practice, survey conditions are not that simple, but many theory papers nevertheless address this situation.

Let's start with a definition of the calibration approach proposed by Särndal(2007).

Definition. The calibration approach to estimation for finite populations consists of

(a) a computation of weights that incorporate specified auxiliary information and are restrained by calibration equation(s),

(b) the use of these weights to compute linearly weighted estimates of totals and other finite population parameters: weight times variable value, summed over set of observed units,

(c) an objective to obtain nearly design unbiased estimates as long as nonresponse and other nonsampling errors are absent.

A probability sample s is drawn from the finite population $U = \{1, 2, \dots, k, \dots, N\}$. Denote by π_k the inclusion probability of unit and by the design weight of k . Let y be the variable of interest. The value y_k of the study variable y is recorded for all $k \in s$ (complete response). The

objective is to estimate the unknown mean $\mu_y = \frac{\sum_U y_k}{N}$. The basic design

estimator of μ_y is $\hat{\mu}_y^{HT} = \frac{\sum_{k \in s} d_k y_k}{N}$, the Horwitz-Thompson estimator.

It is unbiased for μ_y and it is the basis for construction of many estimators. It is not always a very good estimator. HT estimator may be seriously deficient. One of the question is to improve an accuracy of the estimate $\hat{\mu}_y$.

A more efficient weighting as compared with HT estimator is usually achieved by using the available auxiliary information. Denote by x_k an auxiliary variable, associated with the k -th unit.

Definition. (Deville and Särndal (1992)) Estimator $\hat{\mu}_{CAL,y} = \frac{\sum_{k \in s} w_k y_k}{N}$

is called calibrated if it estimates the known mean μ_x without error:

$$E\hat{\mu}_{CAL,x} = \mu_x \text{ (or the same } \sum_{k \in s} w_k x_k = \sum_{k \in U} x_k \text{) and the distance between the}$$

weights d_k and weights w_k is minimal according to the loss function $L(w, d) = L(w_k, d_k, k \in s)$

To calculate calibrated weights we solve a minimization problem

$$L(w, d) = L(w_k, d_k, k \in s) \rightarrow \min$$

Note that for some loss functions the explicit solution exists, for others the iterative procedure can be used. Deville and Särndal (1992) show that a variety of distance functions satisfying mild conditions will generate asymptotically equivalent calibration estimators. The most commonly used distance measure is the chi-squared distance $L(w, d) = \sum_s (w_k - d_k)^2 / (q_k d_k)$, where the q_k 's are known positive constants uncorrelated with the d_k 's.

Calibrated weights can be less than 1 or negative (for some loss functions). (It may cause a real problem when, for example, estimating totals for domains.) Questions about the existence of a solution to the calibration equation are discussed in Th  berge (2000).

we obtain that calibrated mean estimator is equal to

$$\hat{\mu}_{CAL,y} = \frac{\sum_{k \in s} w_k y_k}{N} = \hat{\mu}_y^{HT} + \hat{\beta}(\mu_x - \hat{\mu}_x^{HT}), \quad (1)$$

where $\hat{\beta} = (\tilde{x}\tilde{x}')^{-1}\tilde{x}'\tilde{y}$, $\tilde{x} = (\tilde{x}_k)_{k \in s}$ is a matrix with corrected vectors $\tilde{x}_k = \sqrt{q_k d_k} x_k$, $\tilde{y}_k = \sqrt{q_k d_k} y_k$.

References

1. Alexander, C.H. (1987). A class of methods for using person controls in household weighting. *Survey Methodology*, 13, P.183-198.
2. Bankier, M.D., Rathwell, S. and Majkowski, M. (1992). Two step generalized least squares estimation in the 1991 Canadian Census. Working paper, Census Operations Section, Social Surveys Methods Division, Statistics Canada.
3. Kova  evi  , M.S. (1997). Calibration estimation of cumulative distribution and quantile functions from survey data. *Proceedings of the Survey Methods Section, Statistical Society of Canada*, P.139-144.
4. Lehtonen, R., S  r  dal, C.E. and Veijanen, A. (2003). The effect of model choice in estimation for domains, including small domains. *Survey*

Methodology, 29, 3344.

5. Rueda, M., Martínez, S., Martínez, H. and Arcos, A. (2007). Estimation of the distribution function with calibration methods. Journal of Statistical Planning and Inference, 137, P.435-448.

6. C.-E. Särndal (2007). The calibration approach in survey theory and practice. Survey methodology, 33(2), P.99-119.

THE GROUNDING FOR INDICATORS OF QUALITY OF EDUCATION IN HEI

(Higher Educational Institutionals)

Savkova Valentina, Marx Gómez Jorge

valentina.savkova@gmail.com,

jorge.marx.gomez@uni-oldenburg.de

The choice of parameters is performed according to the structure of the organization and leading EP in HEI [2,3] and is divided into three blocks: - Block 1 - indicators of impact on the organization and conducting of the entrance campaign; Block 2 - indicators of impact on the organization and conduct of EP in HEI; - Block 3 - interning on a first position at work. These units are consist of the following indicators of impact on the EQ of HEI: Block 1 ($A_{11} \div A_{17}$): $A_{11} = \{\text{requirements to availability and adequacy of documents}\}$; $A_{12} = \{\text{requirements for the number of points in the certificate of Centre of the evaluation of EQ}\}$; $A_{13} = \{\text{requirements for the number of points for participating in the contest}\}$; $A_{14} = \{\text{requirements for evaluating the state of health}\}$; $A_{15} = \{\text{requirements for individual psychological assessment as a candidate}\}$; $A_{16} = \{\text{requirements}\}$ medical examination; Block 2 ($A_{21} \div A_{28}$): $A_{21} = \{\text{requirements for organization of self-training}\}$; $A_{22} = \{\text{organization}\}$ current control knowledge; $A_{23} = \{\text{attendance of a lessons by a student}\}$; $A_{24} = \{\text{availability of textbooks and training manuals on subjects, their quality}\}$; $A_{25} = \{\text{controlling the activities of the leadership of the organization and attendance}\}$; $A_{26} = \{\text{equipment reading rooms, laboratories, classrooms, special. Audiences}\}$; $A_{27} = \{\text{motivation of a student}\}$; $A_{28} = \{\text{organization, discipline and conscientious attitude to learning of a student}\}$; Block 3 ($A_{31} \div A_{37}$): $A_{31} = \{\text{professional competencies of a student}\}$; $A_{32} = \{\text{business competencies of a student}\}$; $A_{33} = \{\text{level of a teacher competence}\}$; $A_{34} = \{\text{level of compliance with the requirements of the teacher in daily activities}\}$; $A_{35} = \{\text{personal qualities}\}$; $A_{36} = \{\text{level of discipline}\}$; $A_{37} = \{\text{moral and ethical qualities}\}$. Gaining a weight coefficients and

the priority of each indicator of impact on EQ in HEI is performing using the analytic hierarchy process (AHP): $\overrightarrow{A\overline{H}} = \lambda \overrightarrow{N}$;

$$\overrightarrow{H}_{\max} = \begin{pmatrix} H_1 \\ H_2 \\ \vdots \\ H_N \end{pmatrix}; \quad \overrightarrow{W} = q \overrightarrow{H}_{\max}; \quad q = \frac{1}{\sum_{n=1}^N H_n}; \quad \sum_{n=1}^N W_n = 1, W_n \geq 0.$$

$$W_{i1} \geq W_{i2} \geq W_{i3} \geq \dots \geq W_{iN}. \quad \{A_i, i=1, \overline{N}\} \Rightarrow \{(A_{ik}, W_{ik}), k=1, \overline{N}\}.$$

PROPERTIES OF THE PERTURBED CONES IN VECTOR OPTIMIZATION PROBLEM [†]

Semenova N.V., Lebedeva T.T., Sergienko T.I.

V.M.Glushkov Institut of Cybernetics of NASU, Ukraine

nvsemenova@meta.ua, lebedtt@i.com.ua

A discrete vector optimization problem $Z(M(F, X))$: $\max\{F(x) \mid x \in X\}$, is considered, which consists of search of elements optimal set solutions $M(F, X) \in \{Sl(F, X), P(F, X), Sm(F, X)\}$, where, $P(F, X)$ – set of Pareto-optimal solutions, $Sl(F, X)$ – set of Slater-optimal solutions, $Sm(F, X)$ – set of Smale-optimal solutions. We will put in order the feasible area of problems $Z(M(F, X))$ by means of polyhedral cone $K = \{x \in R^n \mid Cx \geq 0\}$. Effects of input data perturbations on the solutions of vector optimization problems are investigated [1-3]. Analysis of properties of perturbed cones which partially order the vector optimization problem feasible domain with respect to the linear objective functions were carried out. Structure of the set of specific perturbed ordering cones with different values of parameter of perturbations of input data were studied.

The expounded results undertaken studies allow substantially to extend an idea about properties and structure of set by the special character of perturbed cones, putting in order the set of feasible solutions of vector optimization problems. The got results can be drawn

[†] This work was supported by the State Foundation of Fundamental Research of Ukraine (the project 54.1/039).

on in development of theory of well-posedness of vector optimization problems, including problems fully and partly integer optimizations.

References

1. Сергиенко И.В., Козерацкая Л.Н., Лебедева Т.Т. Исследование устойчивости и параметрический анализ дискретных оптимизационных задач. – Киев: Наук. думка, 1995.–170 с.
2. Kozeratska L., Forbes J.F., Goebel R.J., Kresta J.V. Perturbed cones for analysis of uncertain multi-criteria optimization problems // Linear algebra and its applications. – 2004. – N 378. – P. 203-229.
3. Лебедева Т.Т., Семенова Н.В., Сергиенко Т.И. Качественные характеристики устойчивости векторных задач дискретной оптимизации с различными принципами оптимальности // Кибернетика и системный анализ. – 2014. – № 2. – С. 75–82.

SEMILOCAL CONVERGENCE ANALYSIS OF COMBINED METHODS

Shakhno S.M., Yarmola H.P.

Ivan Franko National University of Lviv, Ukraine
s_shakhno@franko.lviv.ua, halina_yarmola@ukr.net

Consider the equation

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

where F and G are nonlinear operators, defined on a convex subset D of a Banach space X with values in a Banach space Y . F is a Frechet-differentiable operator, G is a continuous operator, differentiability of which is not required.

For solving equation (1) we proposed two-point combined methods [2, 3]. These methods are based on Newton's method, method of a linear interpolation and two-step methods with derivatives and divided differences. The formulas of the methods are:

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

$$x_{n+1} = x_n - A_n^{-1} H(x_n), \quad y_{n+1} = x_{n+1} - A_n^{-1} H(x_{n+1}), \quad n = 0, 1, \dots, \quad (3)$$

where $A_n = F'\left(\frac{x_n + y_n}{2}\right) + G(x_n; y_n)$.

We also investigated the method [1]

$$x_{n+1} = x_n - [F'(x_n) + G(x_{n-1}; x_n)]^{-1} H(x_n), \quad n = 0, 1, \dots \quad (4)$$

Semilocal convergence of the methods (2) - (4) was studied under generalized Lipschitz conditions for derivatives and divided differences. These conditions are more general and include classical Lipschitz conditions. Also we established the conditions under which the methods converge to the unique solution of equation (1).

References

1. Argyros I.K. A unifying local-semilocal convergence analysis and applications for two-point Newton-like methods in Banach space // J. Math. Anal. Appl. – 2004. – V. 298. – P. 374–397.
2. Shakhno S.M. Convergence of the two-step combined method and uniqueness of the solution of nonlinear operator equations // J. Comp. App. Math. – 2014. – Vol. 261. – P. 378–386.
3. Shakhno S.M., Yarmola H.P. Two-point method for solving nonlinear equations with nondifferentiable operator // Matematychni Studii. – 2010. – Vol. 36, No 2. – P. 213–220. (in Ukrainian)

ON CONJUGATE TRIGONOMETRIC SERIES

Shatashvili Albert , Bakuridze Mzevinar , Didmanidze Marina

Batumi Shota Rustaveli State University, Georgia

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

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

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

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

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

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

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

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

Therefore $L^\infty(T) \equiv C(T)$ and $\|f\|_c = \|f\|_\infty = \sup_{x \in T} |f(x)|$.

If $f \in L^p(T)$, $p \in [1, +\infty]$ and $\delta > 0$, then the representation $\omega(\delta, f)_p = \sup_{|h| \leq \delta} \|f(\cdot + h) - f(\cdot)\|_p$, is called L^p -modulus of continuity of function f .

Let's note that $\omega(\delta, f)_c = \omega(\delta, f)_\infty$.

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

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

MINIMAX ESTIMATING FOR THE VOLATILITY SURFACE

Shchestyuk N.

National University "Kiyv-Mohila Academy", Ukraine

Natalyshch@gmail.com

The Black–Scholes–Merton model [1] gives options prices as a function of volatility. If an option price is given by the market we can invert this relationship to get the implied volatility. If the model were perfect, this implied value would be the same for all option market prices, but reality shows this is not the case. Implied Black–Scholes volatilities strongly depend on the maturity and the strike of the European option under scrutiny. It is easy to solve this paradox by allowing volatility to be time-dependent, as Merton did (see Merton [2], 1973). However, the dependence of implied volatility on the strike K , for a given maturity T (known as the smile effect) is trickier. The spot process S is then governed by the stochastic differential equation Dupire [3].

The volatility surface $\sigma(K, T)$ is a function of the strike K and expiration T . It is constructed using market prices of European call and put options. The volatility surface $\sigma(K, T)$ is defined implicitly by

$$C_{mkt}(S, K, T) = C_{B-S}(S, T, R, K, \sigma(K, T)),$$

where $C_{mkt}(S, K, T)$ denotes the market price of the call option with expiration T and strike K and $C_{B-S}(\cdot)$ is the corresponding Black-Scholes formula for pricing this call option.

The volatility surface is very important for risk management purposes and scenario analysis. But from definition we have only a number of points on our surface and we need fill in the rest of the surface using some sort of interpolation or extrapolation procedure.

In this paper the discrete volatility surface $\sigma(K, T)$ was constructed for GOOGLE options and considered as random field $\sigma(u, v)$ for $(u, v) \in D \subseteq Z^2$ [4]. We want to predict unknown values of a random field $\sigma(K, T)$, $(K, T) \in P \not\subset D$ from observations of the field $\sigma(u, v)$ for $(u, v) \in D \subseteq R^2$. For this aim some classes of correlation uncertainty are considered. Problem of estimation of the functional

$A_P \sigma = \sum_{(u,v) \in P} a(u, v) \sigma(u, v)$ on the unknown values of a random field

$\sigma(K, T)$, $(K, T) \in P \not\subset D$ from observations of the field $\sigma(u, v)$ for $(u, v) \in D \subseteq Z^2$ is investigated. Formulas are proposed for calculation the mean square errors and spectral characteristics of the optimal linear estimate. The least favourable spectral densities and the minimax-robust spectral characteristics of the optimal linear estimates of the linear functional $A_P \sigma$ are found for some classes of random fields.

References

1. Black, F., and M. Scholes, 1973, "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy*, 81, pp. 637–654.
2. Merton, R., 1973, "The Theory of Rational Option Pricing", *Bell Journal of Economics and Management Science*, 4, pp. 141–83.
3. Dupire, B., 1992, "Arbitrage Pricing with Stochastic Volatility", *Proceedings of AFFI Conference*, Paris, June.
4. Moklyachuk, M. and Shchestyuk, N. 2005, Estimation problems for random fields from observations in discrete moments of time. *Theory of Stochastic Processes*. – 2004. – N 1-2. pp.141-154.

TRANSITIONAL MODAL LOGICS OF NON-MONOTONE PARTIAL PREDICATES

Shkilniak Oksana S.

Taras Shevchenko National University of Kyiv, Ukraine
me.oksana@gmail.com

Modal logic is an extension of classical mathematical logic which is a more powerful tool for expressing and analysis: e.g., temporal logics are used for dynamic systems modelling, software systems specification and verification; epistemic modal logics are used for description of intelligence systems, databases and knowledge bases with incomplete information. However, classical logic has some fundamental restrictions which don't allow taking into account sufficiently such properties of subject-domain information as incompleteness, partiality, uncertainty. This leads to a problem of construction of new program-oriented logical formalisms based on wide classes of partial mappings over nominative data. Composition-nominative modal logics [1] could be such a formalism. Their important variant, modal transitional logics (MTL), can adequately represent changes and development of subject-domains.

The report introduces MTL of partial quasi-ary predicates without monotonicity restriction (for research dedicated to the equitone (monotone) case of MTL, see [1, 2]). Such logics can be of effective use for description of dynamic and information systems under uncertainty and incompleteness.

We define languages and semantic models of MTL of non-monotone predicates and investigate their semantic properties. Significant difference between MTL of monotone and non-monotone predicates is demonstrated: as an example, the converse Barcan formula is not valid in the case of non-monotone predicates, however (see [2]), this formula is valid in the case of monotone predicates. Properties of logical consequence relations for sets of formulas, specified with states, are considered. Basing on these properties, corresponding sequent calculi can be constructed.

References

1. Nikitchenko M. and Shkilniak S., Applied Logic. Publishing house of Taras Shevchenko National University of Kyiv, 2013, 278 p. (in Ukrainian)
2. Shkilniak O. , "Semantic properties of composition-nominative modal logics," Problems in Programming, vol. 4, 2009, pp. 11-23. (in Ukrainian)

LOGICS OF PARTIAL AND MULTI-VALUED PREDICATES WITH EXTENDED RENOMINATIONS

Shkilniak Stepan S.

Taras Shevchenko National University of Kyiv, Ukraine
ttp@unicyb.kiev.ua

The apparatus of mathematical logic is widely used in various logical systems in programming and modelling. The systems are usually based on classical predicate logic. However, traditional total single-valued mappings don't allow taking into account sufficiently such properties of subject-domain information as incompleteness, partiality, uncertainty. At the same time, partial mappings over incomplete data can be easily found in programming and modelling; moreover, such mappings are not always single-valued and monotone. So it becomes an important task to introduce and investigate program-oriented logical formalisms based on such mappings. Composition-nominative logics of partial predicates [1] could be such a formalism.

In this paper we study semantic properties of pure first-order composition-nominative logics (PCNL) of partial single-valued, total multi-valued and partial multi-valued predicates. Along with basic PCNL, we consider logics with extended renomination composition $R_{\bar{x}, \perp}^{\bar{v}, \bar{u}}$. These logics called PCNLER. By using it, one can indicate explicitly the absence of value for the subject names (variables), i.e., remove components with undefined names. Also we define compositions of extended quantification $\exists_{\perp} x$ and $\forall_{\perp} x$ through $R_{\bar{x}, \perp}^{\bar{v}, \bar{u}}$.

We describe languages and semantic models of PCNLER and study their semantic properties. The criterion of subject variables strict unessentiality, formulated in terms of extended quantifiers, is proved. Logical consequence relations for sets of formulas $\models_{Cl}$, $\models_{Cm}$, $\models_T$, $\models_F$, $\models_{TF}$ are specified and their properties in various semantics are investigated. These properties allow to construct sequent calculi for such logics.

References

1. Nikitchenko M. and Shkilniak S. . Applied Logic. Publishing house of National Taras Shevchenko University of Kyiv, 2013, 278 p. (in Ukrainian).

SEMI-CONTINUOUS KILLED MARKOV DECISION PROCESSES

¹Shpak P., ²Yeleyko Y.

Ivan Franko University of Lviv, Ukraine

¹prshpak@gmail.com, ²yikts@yahoo.com

We consider semi-continuous killed Markov decision processes [1] which satisfies following conditions:

1. Set of states X and set of actions A – separable metric spaces.
 $X_m, X_{m+1}, \dots, X_n$ – closed subsets of X and $A_{m+1}, \dots, A_n$ – closed subset of A .
2. If $x_k \rightarrow x \in X$ and $a_k \in A(x_k)$ then exists limit point of sequence $\{a_k\}$, which belongs to set $A(x)$.
3. If $f \in \mathcal{L}(X_t)$ and $g(a) = \int_{X_t} p(dx|a)f(x)$ ($a \in A_t$) then
 $g \in \mathcal{L}(A_t)$ ($t = m+1, \dots, n$) (where $\mathcal{L}(E)$ – set of all semi-continuous functions on E [1]).
4. Reward function q belongs to $\mathcal{L}(A_t)$ and terminal reward r belongs to $\mathcal{L}(X_n)$.

We introduce crash function [2], defined on a subset X^* of a set керувань X and probability measure defined on space of ways L :

$$P(l) = \begin{cases} \mu(dx_m)\pi(da_{m+1}|x_m)p(dx_{m+1}|a_{m+1})\dots p(dx_n|a_n), & \forall t, x_t \notin X^* \\ \mu(dx_m)\pi(da_{m+1}|x_m)p(dx_{m+1}|a_{m+1})\dots p(dx_k^*|a_k), & x_k^* \in X^*. \end{cases}$$

We investigate fundamental equation and conditions of existence of measurable optimal policies.

References

1. Dynkin E.B., Yushkevich A.A. Markov Decision Processes, M., 1975, 334 p.(Russian).
2. Parolya N. R., Yeleyko Y. I. Killed Markov decision processes on finite time interval for countable models, Transactions of NAS of Azerbaijan, 2010, vol. XXX, No 4, pp. 141-152.

ENVIRONMENTAL INFORMATION SYSTEMS ENGINEERING EXPERIENCE

Sirenko Igor, Stelia Igor

Taras Shevchenko National University of Kyiv, Ukraine

i.sirenko@gmail.com, igor.stelia@gmail.com

There are given the developed information systems and examples of their application in the field of environmental protection.

- " Chronicle of Nature " information system is designed for inventory and monitoring of biodiversity in reserves and national natural parks of Ukraine. The system integrates at functional level the database (DB) with the interface program of the user for data input and editing, and also software which forms and implements information requests to DB in a friendly for user interface. The database includes general information, data on territory flora and fauna, data on protected species, etc.

- Information system of the rural water supply objects certification. The system makes it possible to create a uniform information databank for consolidation of information on a condition of sources and objects of rural water supply with the subsequent analysis of a situation.

- Greencity information system for inventory of urban plantation allows to carry out the analysis of inventory and monitoring data. The system includes the following units: help system, database with the interface, mapping unit, inquiry unit and report generation unit in the form of thematic maps and paper documents. All units are united by the common user interface. The system includes the cartographical unit and can be adapted for use in parks, reserves and botanical gardens.

- Information monitoring system of pollutants discharge with drainage water into the Black Sea. The system allows to calculate the spillover of polluting substances in the discharge points and in the automated mode to display necessary charts on the digital map.

DECISION SUPPORT INFORMATION TECHNOLOGY IN PORTFOLIO MANAGEMENT BASED ON FORECAST METHODS

Skachko D.O., Skachko I.O

International Research and Training Centre for Information
Technologies and Systems, Ukraine
tnessik@gmail.com

Problem statement. Over the last years, decision-making problems in portfolio management have become of major interest in the field of investment activities of organizations at the Ukrainian market. On a day-to-day basis, significant amounts of stocks are sold and purchased with the purpose of generating a profit. The efficiency of decision-making in portfolio management depends greatly on the reliability and accuracy of price fluctuation forecasts. That is why short-term securities forecasting is of great practical significance for investors' business activities.

The information on stock price performance gives us the impression of hectic motion: falls and rises of stocks succeed one another randomly. Even if we have been observing an upward stock trend over a large time interval, should we take a closer look at the chart, we will see that this trend paves its way through complex motions of the time series. The series direction constantly changes influenced by irregular and often unknown forces. The forecast has to be made. Usually this task is assigned to experts who can analyze the current market situation and identify factors, which influence the stock motion on a regular basis. That is why we set ourselves the following task. Firstly, we will try to study the applicability of statistical methods, aimed at describing recurring events or situations characterized by relatively stable connections, for short-term securities forecasting. Secondly, if the above-mentioned statistical methods can be applied to complete this task, we will seek to identify their most promising class, distinguish the unique characteristics of these methods and review the simplest ones in detail. Finally, we will show their practical use.

General formulation. The object of research is the time series of successive daily data on bigname stocks that we will write down as $x_1, x_2, \dots, x_n$ where N – is the series length, or the length of the examined truncated series, to be more specific. Our task was to detect a more or less stable dependence of the i^{th} observation from the previous ones and, based on this, to make a forecast for the $(N+1)^{th}$ moment.

As a statistical base for this research, we used the bigname stock data: AZST, BAVL CEEN DOEN, MSICH. The length of each time series was randomly assumed to be equal to 150 daily observations from 01.02.2013 till 01.09.2013. We have previously made sure that the initial series are not absolutely random (not a white noise where there is no dependence between the series values, which are related to different moments, and the future motion direction of which is equally possible, i.e., unpredictable). The selected series have been tested using the criteria of randomness: the turning point criterion, the phase length distribution criterion and the criterion based on rank correlation. We used the adaptive model class, since these models absorb new information and can adjust their parameters based on the forecast error made at the previous stage. We need a forecast for the next day but all we have to do to gain positive effect is to foresee the motion of the stock up or down. We will begin to construct the model by looking at the following product $m_i = k_i k_{i-1}$. It is easy to notice that

$$m_i = \begin{cases} +1, & \text{when } k_i = 1 \text{ and } k_{i-1} = 1 \quad \text{when } k_i = -1, k_{i-1} = -1 \\ 0, & k_i = 1 \text{ or } k_{i-1} = 0 \\ -1, & \text{when } k_i = 1 \text{ and } k_{i-1} = -1 \quad \text{when } k_i = -1 \text{ and } k_{i-1} = 1. \end{cases}$$

The first equation in this expression corresponds to the stock motion trend maintenance as you go from one moment to another, the third equation shows the change in the trend, in this case, it is about the turning point, and in the second equation, it is about an uncertain situation. To find out, which situation is the most common today, we should **find** a way to average out the m_i series

for a known interval. To do that, let us use the exponential smoothing method.

$$S_t = \alpha m_t + \beta S_{t-1}, \quad (1)$$

where S_t - exponential average value at t

α - smoothing constant (adaptation parameter), $\beta = 1 - \alpha$.

The expression (1) can be rewritten in the following way

$$S_t = \alpha m_t + (1 - \alpha) S_{t-1} = S_{t-1} + \alpha (m_t - S_{t-1}) \quad (2)$$

Where S_{t-1} can be viewed as a one-step ahead forecast, as an

m_t value forecast made at $t - 1$, in this case the value $(m_t - S_{t-1})$

is the error of the given forecast, the new forecast is the result of the previous forecast adjustment in respect to its error. This is what forecast model adaptation means. The best value of α is established through a trial and search process aimed at minimizing the losses and maximizing the gains.

Conclusions

We have carefully examined the adaptive model, which can be applied to the real data. The overall results are positive, though there is still no way we can avoid the risk altogether. The proposed approaches to short-term **securities** forecasting allow experts to make efficient decisions. Broadly speaking, the forecast itself is background information for the second phase of work, which is developing an optimal solution.

References

1. *Sharp W.* Simplified model for portfolio analysis // Management Sciences. 1963, vol.9, № 2.
2. *Tobin J.* Liquidity Preference as Behavior Towards Risk // Review of Economic Studies, 26, № 1 (February 1958).
3. *Tobin J.* The Theory of Portfolio Selection. The Theory of Interest Rates // ed. By Hahn F. and Brechlin, London, Macmillan and Co., 1965.
4. *Merton R.* An International Capital Asset Pricing Model // Econometrica (September 1973).

AGGREGATION APPROACH IN GROUP DECISION MAKING

Skarga-Bandurova I.

Technological Institute of Volodymyr Dahl East Ukrainian National
University, Ukraine

skarga_bandurova@ukr.net

The report presents the aggregation approach and explains multiple criteria decision methods developed to assist industrial authorities in the management of complex environmental protection projects.

Group decision making is a situation where two or more decision makers are involved in decision of a joint problem whereas each of them has their own understanding of the problem and the decision consequences. In this situation the individual preferences must be aggregated and there are at least two kinds of aggregation - behaviors aggregation and formal one.

Behaviors aggregation is the process by which decision group are able to trade-off their expectations and agree on a common system of objectives and preferences. After a communicative phase, decision makers as a rule assume a unified problem structure and common value functions.

In complex situations where occurs an interdisciplinary incomprehension the individual solutions can be represented and compared through formal aggregation procedures to select a uniform solution. One of the most common methods of formal aggregation is a method using ordered weighted average operators (OWA) introduced by R. Yager in [1].

In this report, we represent a series of classical OWA, and develop some new aggregating operators, establish various properties of these operators, and then apply them to develop new approaches to multiple group decision making with both probabilistic and fuzzy information, and with different sequence order. Moreover, we extend these aggregation operators and decision making approaches to interval environments. Finally, we show how the use of the proposed approach allows decision group members to search for satisfying solutions and to evaluate them.

References

1. Yager, R.R. On ordered weighted averaging aggregation operators in multi-criteria decision making / R.R. Yager. – IEEE Trans. Systems, Man and Cybernetics. – 1988. – vol. 18. – pp. 183-190.

RECURRENT LEAST SQUARES **NON-STATIONARY PARAMETER ESTIMATION WITH** **LEAST DEVIATION NORM FROM ‘ATTRACTION’ POINTS** **FOR SYSTEMS UNDER UNCERTAINTIES**

Slabospitsky Alexander S.

Taras Shevchenko National University of Kiev, Ukraine

sl@univ.kiev.ua

Consider the identification of slowly time-varying parameter vector α in situation when for α its ‘attraction’ point $\alpha_*(N)$ is known at any moment N ($N = 0, 1, 2, \dots$). The least squares estimate with variable forgetting factor $\lambda(i)$ is investigated in non-classical case when this estimate may be not unique for model:

$$y(k) = x^T(k)\alpha + \xi(k), \quad k = \overline{1, N}, \quad N \in \mathbb{N},$$

where $y(k)$, $\xi(k)$ are scalar observation and error model, respectively, vector $x(k)$ is given, $\alpha \in \mathbb{R}^P$, $\lambda(i) \in (0, 1]$, $i \in \mathbb{N}$. The last-named estimate may be not unique and set of these estimates is defined as

$$\underset{\alpha}{\text{Arg min}} Q(\alpha, N),$$

where

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

The least squares estimate $\hat{\alpha}(N)$ with variable forgetting factor $\lambda(i)$ and least deviation norm from ‘attraction’ point $\alpha_*(N)$ at moment N is proposed as unique estimate on before-mentioned estimate set:

$$\hat{\alpha}(N) = \tilde{X}_N^+ \tilde{y}_N + \left(E_p - \tilde{X}_N^+ \tilde{X}_N \right) \alpha_*(N), \quad N \in \mathbb{N},$$

where $(^+)$ – Moore-Penrose pseudo-inverse operator,

$$\tilde{y}_N = \text{column} \left(\sqrt{w(1, N)} y(1), \dots, \sqrt{w(N, N)} y(N) \right),$$

$$\tilde{X}_N = \text{column} \left(\sqrt{w(1, N)} x^T(1), \dots, \sqrt{w(N, N)} x^T(N) \right).$$

Two forms of recurrent representation for $\hat{\alpha}(N)$ are suggested without use of matrix pseudo-inversion. Recurrent algorithm for weighted residual sum of squares $q(N) = Q(\hat{\alpha}(N), N)$ is obtained too.

COMPARATIVE ANALYSIS OF TRAFFIC CONTROL METHODS

Slavko B.V.

Taras Shevchenko National University of Kyiv, Ukraine

slavkobogdan@gmail.com

In this study we consider the problem of optimal traffic control where the value of the optimality criterion is represented by the value of average time spent before leaving a crossroad.

We assume that during the time τ car arrives at the crossroad (in i -th direction) with probability λ_i and does not arrive with probability $1 - \lambda_i$. In case of “green light” car passes with probability ω_i and does not pass with probability $1 - \omega_i$ ($i=1,2$). We assume that numbers of cars waiting at the crossroad are limited with N_i ($i=1,2$) and car flows are independent. There are several possible ways of traffic control under such conditions.

The fixed-mode automaton is control system keeping “green light” during the time $a_1\tau$ for the first traffic flow and $a_2\tau$ for the second one (a_1, a_2 are positive integers). If the sum $a_1 + a_2$ is fixed a_1 may become a parameter of optimization. To solve such complicated problem we use stochastic simulation approach and genetic algorithms.

The feedback automaton [1] is control system which chooses the flow in accordance to the rule fixed for each state of the system. The state of the system is represented by random vector $X(t) = (X_1(t), X_2(t))$, $X_1(t)$ is number of cars in the first line and $X_2(t)$ is the same value for the second one. This model is solved with the help of Howard algorithm for Markov decision processes with several ergodic sets [2].

References

1. Neymark Y.I. Feedback traffic control automaton / Neymark Y.I., Fedotkin M. A., Preobrazhenskaya A. M. - Technical cybernetics – 1968 (5). – p.1-11 (in Russian).
2. Ховард Р. A Dynamic programming and Markov processes / Howard R.A. – Cambridge, MA: The MIT Press, 1971 - pp. 3-84.

PRACTICAL PRESENTATIONS OF RISK FUNCTION IN APPLIED PROBLEMS OF DECISION-MAKING

Stefanyshyna-Gavryliuk Yuliya D.,

Stefanyshyn Dmytro V.

The Institute of Telecommunications and Global Information
Space of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
stefanishina@yahoo.com, dvstefanyshyn@yahoo.com

The problem adopting the optimal decision in terms of risk can be written as follows [1]:

$$\mathbf{A}_{opt} = \{a_{i,opt} \mid a_{i,opt} \in \mathbf{A} \wedge r_{i,opt} = \min_i(r_i)\}, \quad (1)$$

where $\mathbf{A}_{opt}$ is a set of optimal alternatives $a_{i,opt}$ belonging to the set $\mathbf{A}$ of all alternatives and assessment of adverse outcome $r_{i,opt}$ which is the lowest among all ratings r_i . Outcome r_i will be called a risk.

To quantify the risk may be offered different evaluation functions. Such functions will be called risk functions.

Considered are some typical presentations of risk functions that can be used in applied problems of decision-making in engineering, technology, ecology and economy.

Let there the set of alternatives among which it should be chosen the best one using the criteria for minimal risk (1) be. It is shown that the comparison of alternatives on risk [2], appropriate evaluation functions of alternatives can be given as the functions of additional risk, components of which are based on estimates by which extreme among alternatives ordered in increasing for one of the evaluation criteria are characterized.

References

1. Muschick E. Entscheidungspraxis: Ziele, Verfahren, Konsequenzen / E. Muschick, P. Müller. VEB Verlag Technik. Berlin. 1986.
2. Stefanyshyna Yu.D. A method of selection of investment portfolio in natural resources use management with taking into account of risk of lost opportunities / Yu.D. Stefanyshyna, D.V. Stefanyshyn // Proc. of Int. Scientific School «Modelling and Analysis of Safety and Risk in Complex Systems». 28.06-02.07, 2011. S-Petersburg. – P.P. 192-198.

COMPUTER MODELING FOR THE SOLUTION OF ENVIRONMENTAL PROBLEMS

Stelia Oleg, Tsukanova Diana

Taras Shevchenko National University of Kyiv, Ukraine

oleg.stelya@gmail.com

KRISFLOW Hydrogeological Computer Model

KRISFLOW HCM is designed for determination of the depth of groundwater, depending on various factors, in particular agricultural practices and drainage system regime. Model allows:

- systematizing the information characterizing the long-term regime of flooding,
- predicting the dynamics of groundwater in accordance with natural, agricultural, and technological factors,
- justifying the solutions on reconstruction and optimization of the drainage network,
- predicting groundwater contamination with herbicides and pesticides from agricultural practices.

The software is used to manage an irrigation system Kahovska.

Drainage Optimization Model

The model is designed for improvement of drainage schemes and development of optimal drainage regimes for areas underflooded by groundwater. Model allows:

- determining the optimal drainage system regime (water pumping rate providing the normal groundwater level) depending on data in monitoring wells,
- carrying out the decision-making support upon drainage design.

Use of a complex allows creating the optimal layouts of drainage of the drowned territories, irrigating systems and industrial zones. It will help to improve an ecological condition of adjacent territories by retardation of water-logging, erodibility and soil salination processes.

ABOUT UNCLEARNESS AND INFINITE IN COMBINATORIAL OPTIMIZATION

Timofeeva N.K.

International Scientific and Training Center for Information
Technologies and Systems, Ukraine
tymnad@gmail.com

The argument of objective function in combinatorial optimization are combinatorial configurations (permutations, partitioning, selections of different types and others like that) [1]. In some problems we can represent them as input data. Combinatorial configurations show by itself any aggregate of elements, which appears from all or from some elements of base sets $A = \{a_1, \dots, a_n\}$. Will designate them w . They form a combinatorial sets W . Will name subsets $W_\eta \subset W$ by subsets of isomorphous combinatorial configurations, if its elements w are isomorphous (combinatorial configurations – isomorphous, if number of elements for them identical). For this W simultaneously is finite and infinite, as a number n can acquire arbitrary values. Subsets W_η of placing with reiterations (or combination with reiterations) – finite, and sets W the same combinatorial configurations for the same n – infinite. Such properties are characteristic for fractals. In recognition of speech, electrocardiograms, encephalogram input data are certain signals which show by itself placing with reiterations. From here the unclearness of input data. For example, speech, which answer the same word, to said repeatedly the same announcer or different announcers, differ between itself. In the problem of classification it is infinite base sets, part of elements of which is known, and part is determined in the process of decision of problem, that information enter in the process of decision of problem and changes in time. The argument of objective function in her is the partial partitioning of infinite sets A on η subsets with reiterations. It is infinite.

References

1. Тимофієва Н.К. Теоретико-числові методи розв'язання задач комбінаторної оптимізації. Автореф. дис... докт. техн. наук / – Ін-т кібернетики ім. В.М. Глушкова НАН України, Київ. – 2007. – 32 с.

SWITCHED SYSTEM IN RETRIAL QUEUEING

Usar I., Protopop I., Makushenko I.

Taras Shevchenko National University of Kiev, Ukraine

usar@unicyb.kiev.ua

The theory of retrial queues forms one of important field of the general queueing theory. The theory of such systems is subject of the monograph [1] and their different applications one can find in [2].

In this paper a system with limited waiting space and the two services is considered. In the contrast to the traditional queueing systems we deal with model with unlimited orbit. The later means that if an arriving claim find both the servers and waiting space being occupied it becomes the sources of repeated claims. We also supposed that the intensity of input flow depends on the number of the sources of repeated claims. For such a system the condition for ergodic distribution of the number of claims in the system to exist is find. To find that distribution itself we propose an approach involving two stages. On the first one the explicit formula for ergodic distribution for the system with limited orbit was obtained in the matrix form. On the second stage the ergodic distribution for unlimited orbit has been obtained from the formula obtained on the first stage by using approximation. The estimation of the rate of convergence of the ergodic distribution for the system with finite orbit to that of unlimited one is obtained as well.

References

1. Falin G.I., Templeton J.G.C. Retrial queues.– London Chapman & Hall, 1997. – 331p.
2. Anisimov V.V., Artalejo J.R. Analysis of Markov multiserver retrial queues with negative arrivals // Queueing Systems. – 2001. – Vol.39. – Pp. 157-182.

USING OF TEMPLATES IN ALGEBRAIC FUNCTIONAL NETWORKS FOR SIMULATION OF TECHNOLOGICAL PROCESSES

Vergunova I.M.

Taras Shevchenko National University of Kyiv, Ukraine

vergunova@bigmir.net

The Mamdani FLC usually considering as a knowledge-based alternative to conventional control of technological processes. It can be applied for modification of control strategy in general.

For solving the task of the control of technological processes of growing agricultural crops within a certain technological scheme [1] we used Mamdani-type FLC [2], where

$\Delta u(k) = u(k) - u(k-1)$ - change of the control,

$\Delta e(k) = e(k) - e(k-1)$ - change of the error of the control,

$u(k) = f(e(k), \Delta e(k)) = K_p e(k) + K_d \Delta e(k)$, K_p, K_d - parameters,

$e(k) = w(k) - y(k)$, w, y - variables, $1, \dots, k-1, k, \dots, n$ - sequentially ordered in time the technological steps.

To account for the structure of an algebraic functional network in received fuzzy systems model convenient to use the template-based approach. The family of all possible elemental rules for a given partitioning of the input and output spaces constructed into the grid provide a fuzzy region in the Cartesian product space.

For this case it is possible easily made the extension to multiple inputs.

In this method we associate with each elemental rule a value indicating the credibility (weight) of this rule being an appropriate rule for the system being modeled.

For the solving of the task of learning the weights of the rules we take adaptive FAM Rule learning approach.

References

1. Vergunova I. The algebraic functional structures for analyze of the agrotechnologies / I. Vergunova // The algebraic functional structures for analyze of the agrotechnologies: XX Int. Conf., (PDMU-2012), Sept. 17-21, 2012, Brno, Czech Republic: abstracts. – 2012. – Pp. 127-128.
2. Yager Ronald R. Essentials of Fuzzy Modeling and Control / Ronald R. Yager, Dimitar P. Filev. – A Wiley–Interscience Publication, John Wiley & Sons, Inc., 1994. – 390 p.

MATHEMATICAL MODELLING OF HEAT AND MASS TRANSFER EFFECT ON THE STRESS-STRAINED STATE OF SOIL ARRAY ON THE AVAILABILITY OF MOVING FREE SURFACE AND STRENGTH OF CONNECTIVITY IN TWO- DIMENSIONAL STATEMENT

Vlasyuk A.P., Zhukovska N.A.

Private Higher Education Establishment Academician Stepan
Demianchuk International University of Economics and Humanities
National University of Water Management and Nature Resources Use,
Ukraine

A.P.Vlasyuk.rv@gmail.com, N.A.Fedorchuk@mail.ru

The problem of modelling of heat and mass transfer effect on the stress-strained state (SSS) of soil array on the availability of moving free surface and strength of connectivity is considered (see Fig. 1).

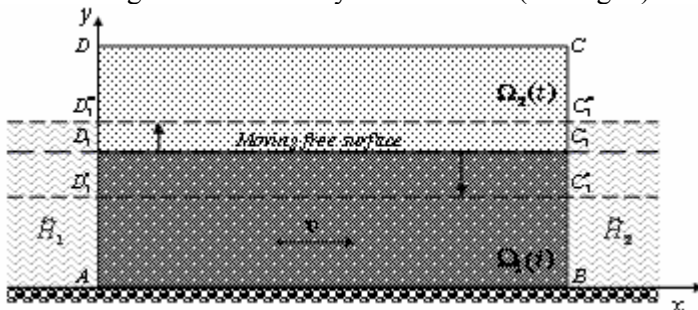


Fig.1. The soil array with moving free surface under heat and mass transfer

The mathematical model of this problem in two-dimensional statement in generally accepted designations may be described by the following boundary value problem [1, 2]:

$$\begin{aligned}
 & \mu(c,T)\Delta U + (\lambda(c,T) + \mu(c,T))\frac{\partial}{\partial x}\left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y}\right) + \left[\frac{\partial \lambda(c,T)}{\partial x}\left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y}\right) + \right. \\
 & \left. + 2\frac{\partial \mu(c,T)}{\partial x}\frac{\partial U}{\partial x} + \frac{\partial \mu(c,T)}{\partial y}\left(\frac{\partial U}{\partial y} + \frac{\partial V}{\partial x}\right)\right] - (2\lambda(c,T) + 2\mu(c,T))\alpha_T\frac{\partial T}{\partial x} = X, \\
 & \mu(c,T)\Delta V + (\lambda(c,T) + \mu(c,T))\frac{\partial}{\partial y}\left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y}\right) + \left[\frac{\partial \lambda(c,T)}{\partial y}\left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y}\right) + \right. \\
 & \left. + 2\frac{\partial \mu(c,T)}{\partial y}\frac{\partial V}{\partial y} + \frac{\partial \mu(c,T)}{\partial x}\left(\frac{\partial U}{\partial y} + \frac{\partial V}{\partial x}\right)\right] - (2\lambda(c,T) + 2\mu(c,T))\alpha_T\frac{\partial T}{\partial y} = Y, \quad (x, y) \in \Omega,
 \end{aligned} \tag{1}$$

$$X = \begin{cases} \frac{dp}{dx} + f_1(c), & (x, y) \in \Omega_1(t), \\ \gamma_{np}, & (x, y) \in \Omega_2(t), \end{cases} \quad Y = \begin{cases} \gamma_{36} + \frac{dp}{dy} + f_2(c), & (x, y) \in \Omega_1(t), \\ \gamma_{np}, & (x, y) \in \Omega_2(t), \end{cases} \quad (2)$$

$$\nabla \cdot (\mathbf{D}(c, T) \nabla c) - \mathbf{v} \nabla c - \gamma(c - C_m) + \nabla \cdot (\mathbf{D}_T \nabla T) = n_p \frac{\partial c}{\partial t}, \quad (x, y) \in \Omega_1(t), \quad (3)$$

$$\nabla \cdot (\lambda_T \nabla T) - \rho c_p \bar{\mathbf{v}} \nabla T = c_T \frac{\partial T}{\partial t}, \quad (x, y) \in \Omega, \quad (4)$$

$$\nabla (\mathbf{K}(c, T) \nabla h - \mathbf{v}_c(c) \nabla c - \mathbf{v}_T \nabla T) = a \frac{\partial h}{\partial t}, \quad (x, y) \in \Omega_1(t), \quad (5)$$

$$\mathbf{v} = -\mathbf{K}(c, T) \text{grad} h + \mathbf{v}_c \text{grad} c + \mathbf{v}_T \text{grad} T, \text{div} \mathbf{v} + \frac{\partial n}{\partial t} = 0, \quad (x, y) \in \Omega_1(t), \quad (6)$$

$$(\bar{\mathbf{v}}, \bar{\mathbf{n}})|_{C_1 D_1} = n \frac{\partial \varphi}{\partial t}, \quad \varphi(x, y, t) = (y - h(x, y, t))|_{C_1 D_1} = 0, \quad h|_{C_1 D_1} = y, \quad (7)$$

$$\varepsilon_x = \frac{\partial U}{\partial x}, \quad \varepsilon_y = \frac{\partial V}{\partial y}, \quad \varepsilon_{xy} = \frac{1}{2} \left(\frac{\partial U}{\partial y} + \frac{\partial V}{\partial x} \right), \quad (8)$$

$$\sigma_x = \frac{\theta}{1+\nu} (\varepsilon_x + \nu \varepsilon_y) - \alpha_T \bar{T} \theta, \quad \sigma_y = \frac{\theta}{1+\nu} (\varepsilon_y + \nu \varepsilon_x) - \alpha_T \bar{T} \theta, \quad \tau_{xy} = 2\mu(c, T) \varepsilon_{xy} \quad (9)$$

and with the appropriate boundary conditions. Here: $(x, y) \in \Omega$, $\Omega = \Omega_1(t) \cup \Omega_2(t)$, $f_1(c)$, $f_2(c)$ are functions which express the influence of soil density on its SSS due to the forces of connectivity, $\bar{v} = v$ at $(x, y) \in \Omega_1(t)$ and $\bar{v} = 0$ at $(x, y) \in \Omega_2(t)$.

There is obtained the numerical solution of boundary value problem (1)-(9). Displacements, stresses, deformations and field distribution pressures, filtration velocities, concentrations of salt solution and temperatures are found. The change of SDS of soil array under heat and mass transfer and strength of connectivity was analyzed.

References

1. Sergienko I.V. Mathematical modelling and the research of processes in non-homogeneous media / I.V. Sergienko, V.V. Skopets'kyi, V.S. Deyneka. – Kyiv: Naukova Dumka, 1991. – 432 p. (in Russian)
2. Vlasjuk A.P. Numerical modeling of stress-strained state of multilayer soil array in the presence of groundwater levels and the impact of heat and mass transfer in one-dimensional statement / A.P. Vlasjuk, N.A. Fedorchuk // Mathematical and computer modeling. Series: Technical sciences: Scientific journal / Kamianets-Podilsky Ivan Ohienko National University, 2013 – Issue. 8 – Pp. 31 – 44. (144p.) (on Ukrainian)

MATHEMATICAL MODELING OF SOIL LAYER STRESS-DEFORMED STATE CHANGE UNDER FLUID FILTRATION VIA RADIAL BASIS FUNCTION METHOD

Vlasyuk Anatoliy, Drozdovskiy Taras

International university of Economics and Humanities named after
Academician Stepan Demianchuk, National University of Water
Management and Nature Resources Use, Ukraine

A.P.Vlasyuk.rv@gmail.com, coldion@gmail.com

In common notation mathematical model of soil layer one-dimensional stress-deformed state change under vertical fluid filtration is represented with such boundary problem [1]:

$$\frac{1}{\sigma} \frac{\partial v}{\partial t} = -\frac{1}{\rho} \frac{\partial p}{\partial y} + g - \frac{g}{k} v, \quad y \in (0; l), t > 0, \quad (1)$$

$$\frac{dl}{dt} = \frac{k}{\sigma} \frac{h+l}{l}, \quad (2)$$

$$(\lambda_i + 2\mu_i) \frac{d^2 u_i}{dy^2} = \gamma_i, \quad y \in \Omega_i, i = 1, 2 \quad (3)$$

and corresponding boundary conditions and conjugation conditions.

Here v - fluid speed, $l = l(t)$ - injecting front position for moment t , u - displacement, $h(y)$ - pressure.

Numerical solution of boundary problem (1)-(3) with corresponding boundary conditions obtained with radial basis method as

$$l_n(X, \varepsilon) = \sum_{j=1}^n a_j \varphi_j(r_j, \varepsilon), \quad u_n(X, \varepsilon) = \sum_{j=1}^n b_j \varphi_j(r_j, \varepsilon). \quad (4)$$

Computational algorithm and software for boundary problem solving was developed. Numerical experiments were carried out with different parameters sets. Relying on obtained data visualization displacement, deformation and tension distributions change was determined. All the results were compared to the work [1] results.

References

1. Vlasyuk A.P., Drozdovskiy T.A. Mathematical modeling of soil layer stress-deformed state change under injecting binding fluid inside it in one-dimensional case / A.P.Vlasyuk, T.A. Drozdovskiy // Mathematical and computer modeling. Series: Technical sciences. – Kamianets-Podilsky : Kamianets-Podilsky National Ivan Ohienko University, 2013. – ISSUE 9. – P. 34-45.

MATHEMATICAL MODELING OF SALT TRANSFER PROCESS UNDER SIMULTANEOUS FILTRATION AND MOISTURE TRANSFER IN SATURATED AND NON- SATURATED SOILS WITH VERTICAL DRAINAGE

Vlasyuk Anatoliy, Tsvetkova Tatyana

International university of Economics and Humanities named after
Academician Stepan Demianchuk, National University of Water
Management and Nature Resources Use, Ukraine
A.P.Vlasyuk.rv@gmail.com, Tsvetkova@ukr.net

Mathematical model of salt transfer process under simultaneous filtration and moisture transfer in saturated and non-saturated soil domains (fig. 1) is formulated in following boundary problem [1,2]:

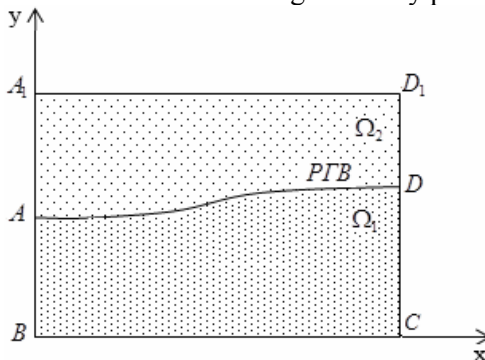


Fig.1. Salt transfer process to vertical drainage in saturated and non-saturated soil domains

$$\frac{\partial \left(D_1(c_1) \frac{\partial c_1}{\partial x} \right)}{\partial x} + \frac{\partial \left(D_1(c_1) \frac{\partial c_1}{\partial y} \right)}{\partial y} - v'_x(c_1) \frac{\partial c_1}{\partial x} - v'_y(c_1) \frac{\partial c_1}{\partial y} - \gamma_1(c_1 - C^*) = \sigma_1 \frac{\partial c_1}{\partial t}, \quad (1)$$

$$\frac{\partial}{\partial x} \left(k_1(c_1) \frac{\partial h_1}{\partial x} \right) + \frac{\partial}{\partial y} \left(k_1(c_1) \frac{\partial h_1}{\partial y} \right) - \frac{\partial}{\partial x} \left(v(c_1) \frac{\partial c_1}{\partial x} \right) - \frac{\partial}{\partial y} \left(v(c_1) \frac{\partial c_1}{\partial y} \right) = a \frac{\partial h_1}{\partial t}, \quad (2)$$

$$v'_x(c_1) = -k(c_1, h_1) \frac{\partial h_1}{\partial x} + v(c_1) \frac{\partial c_1}{\partial x}, \quad v'_y(c_1) = -k(c_1, h_1) \frac{\partial h_1}{\partial y} + v(c_1) \frac{\partial c_1}{\partial y} \quad (3)$$

$$h_1(x, y, 0) = \tilde{H}_0(x, y), \quad h_1|_{AD} = y, \quad \frac{\partial h_1}{\partial n} \Big|_{BC} = 0, \quad h_1|_{AB} = H_1, \quad h_1|_{CD} = H_2 \quad (4)$$

$$c_1(x, y, 0) = \tilde{C}_0(x, y), \quad \frac{\partial c_1}{\partial n} \Big|_{AB \cup BC \cup CD} = 0, \quad (5)$$

$$\frac{\partial \left(D_2(c_2) \frac{\partial c_2}{\partial x} \right)}{\partial x} + \frac{\partial \left(D_2(c_2) \frac{\partial c_2}{\partial y} \right)}{\partial y} - v_x(c_2) \frac{\partial c_2}{\partial x} - v_y(c_2) \frac{\partial c_2}{\partial y} - \gamma_2(c_2 - C^*) = \sigma_2 \frac{\partial c_2}{\partial t}, \quad (6)$$

$$\mu(h_2) \frac{\partial h_2}{\partial t} = \frac{\partial}{\partial x} \left(k(c_2, h_2) \frac{\partial h_2}{\partial x} \right) + \frac{\partial}{\partial y} \left(k(c_2, h_2) \frac{\partial h_2}{\partial y} \right), \quad (7)$$

$$v_x(c_2) = -k(c_2, h_2) \frac{\partial h_2}{\partial x}, \quad v_y(c_2) = -k(c_2, h_2) \frac{\partial h_2}{\partial y}, \quad (8)$$

$$h_2(x, y, 0) = \tilde{H}_0(x, y), \quad h_2|_{AD} = y, \quad \frac{\partial h_2}{\partial n} \Big|_{AA_1 \cup A_1 D_1 \cup D_1 D} = 0, \quad (9)$$

$$c_2(x, y, 0) = \tilde{C}_0(x, y), \quad \frac{\partial c_2}{\partial n} \Big|_{AA_1 \cup A_1 D_1 \cup D_1 D} = 0. \quad (10)$$

Conjugation conditions are set correspondingly for pressure, concentration and salt flows on the saturated and non-saturated domain boundary (groundwater level curve)

$$h_1|_{AD} = h_2|_{AD}, \quad c_1|_{AD} = c_2|_{AD}, \quad v_1 c_1 - D_1 \frac{\partial c_1}{\partial n} = v_2 c_2 - D_2 \frac{\partial c_2}{\partial n}. \quad (11)$$

Boundary problem (1)-(11) difference scheme was constructed using A. Samarskyi's local one-dimensional method. Computational algorithm and software for boundary problem solving was developed. Numerical experiments were carried out with different input data sets. Relying on obtained data visualization pressure, velocity, salt distribution change in saturated and non-saturated soil domains was identified.

References

1. Sergienko I.V. Mathematical modeling of processes in inhomogeneous environment / I.V. Sergienko, V.V. Scopetskyi, V.S. Deineka, - Kiev: Naukova Dumka, 1991. – 273 P.
2. Vlasyuk A.P. Mathematical modeling of salt transfer process under filtration and moisture transfer in saturated and non-saturated stratified soils / A.P. Vlasyuk, T.P. Tsvetkova // Abstracts of XX International Conference “Problems of decision making under uncertainties” – Brno, Czech Republic, 2012. – PP.152-153.

MATHEMATICAL MODELLING OF VERTICAL MIGRATION OF RADIONUCLIDES IN UNSATURATED POROUS MEDIA IN NON-ISOTHERMAL CONDITIONS ONE-DIMENSIONAL CASE

Vlasyuk A.P., Zhukovskiy V.V.

Private Higher Education Establishment Academician Stepan
Demianchuk International University of Economics and Humanities,
National University of Water Management and Nature Resources Use,
Rivne, Ukraine

A.P.Vlasyuk.rv@gmail.com, Zeonet@gmail.com

The problem of radionuclide vertical migration in unsaturated porous media with biporous micro- and nanosized sorbents to trap filter in non-isothermal conditions is considered (see Fig. 1).

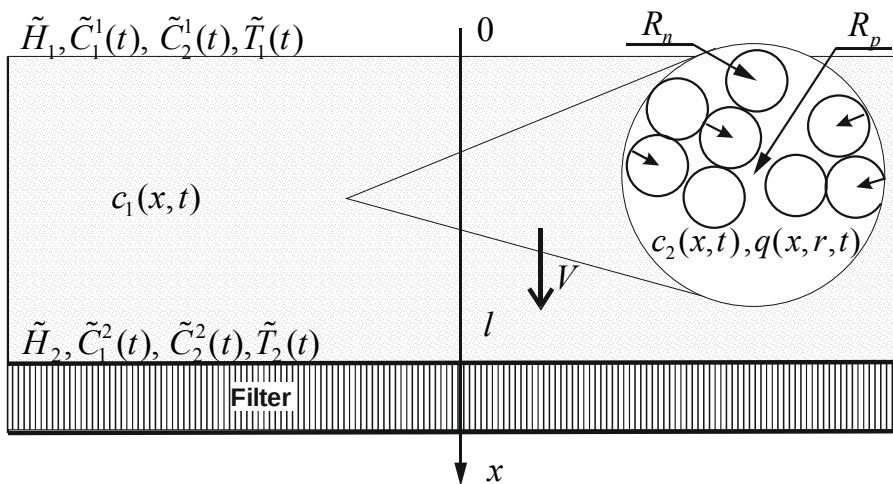


Fig.1. The migration of radionuclides to the filter-traps

The mathematical model of this problem in one-dimensional case in generally accepted designations may be described by the following boundary value problem [1, 2]:

$$\sigma_1 \frac{\partial c_1}{\partial t} = D_1 \frac{\partial^2 c_1}{\partial x^2} + \frac{\partial}{\partial x} \left(D_{T_1} \frac{\partial T}{\partial x} \right) - v_x \frac{\partial c_1}{\partial x} - \gamma_1 c_1 + \gamma_2 c_2, \quad (1)$$

$$\frac{\partial c_2}{\partial t} = \frac{1}{R^2} \frac{\partial}{\partial R} \left(R^2 D_2 \frac{\partial c_2}{\partial R} \right) + \frac{1}{R^2} \frac{\partial}{\partial R} \left(R^2 D_{T_2} \frac{\partial T}{\partial R} \right) + \gamma_1 c_1 - \gamma_2 c_2 - \theta \frac{\partial q}{\partial t}, \quad (2)$$

$$\frac{\partial q}{\partial t} = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 D_0 \frac{\partial q}{\partial r} \right) + \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 D_{T_3} \frac{\partial T}{\partial r} \right), \quad (3)$$

$$\mu(h) \frac{\partial h}{\partial t} = \frac{\partial}{\partial x} \left(k \frac{\partial h}{\partial x} \right) - \nu \frac{\partial c}{\partial x}, \quad \nu_x = -k \frac{\partial h}{\partial x} + \nu \frac{\partial c}{\partial x} + \nu_T \frac{\partial T}{\partial x} \quad (4)$$

$$\left. \frac{\partial q(x, r, t)}{\partial r} \right|_{r=0} = 0, \quad q(x, r, t) \Big|_{r=R_n} = k_e \cdot c_2(x, t), \quad (5)$$

$$\left. \frac{\partial c_2(x, r, t)}{\partial R} \right|_{r=0} = 0, \quad c_2(x, r, t) \Big|_{r=R_p} = c_1(x, t), \quad (6)$$

$$l_1 c_1(0, t) = \tilde{C}_1^1(t), \quad l_2 c_1(l, t) = \tilde{C}_1^2(t), \quad (7)$$

$$l_3 c_2(0, t) = \tilde{C}_2^1(t), \quad l_4 c_2(l, t) = \tilde{C}_2^2(t), \quad (8)$$

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

$$h(0) = \tilde{H}_1, \quad h(l) = \tilde{H}_2, \quad T(x, 0) = \tilde{T}_0(x), \quad (10)$$

$$c_1(x, 0) = \tilde{C}_1^0(x), \quad c_2(x, 0) = \tilde{C}_2^0(x), \quad q(x, r, 0) = \tilde{Q}^0(x, r), \quad (11)$$

where $c_1(x, t)$, D_1 are concentration and coefficient of convective diffusion of radionuclides in the zone of moisture transfer; $c_2(x, t)$, D_2 are concentration and coefficient of molecular diffusion of radionuclides in particles of sorbent with radius R_p ; q , D_0 are concentration and diffusion coefficient of radionuclides in the nanoparticles with radius R_n ; k_e is a coefficient of internal influence of particulate mass transfer on mass transfer in the soil skeleton.

Obtained the numerical solution of boundary value problem (1)-(11) by the method of finite differences. Distribution of concentrations $c_1(x, t)$, $c_2(x, t)$ and $q(x, r, t)$ in unsaturated porous media are found.

References

1. Sergienko I.V. Mathematical modelling and the research of processes in non-homogeneous media / I.V. Sergienko, V.V. Skopets'kyi, V.S. Deyneka. – Kyiv: Naukova Dumka, 1991. – 432 p. (in Russian)
2. Vlasyuk A.P. Mathematical modeling of vertical migration of radionuclides in unsaturated catalytic porous media to trap filter in linear case. / A.P. Vlasyuk, V.V. Zhukovskyy // Modern problems of mathematical modeling, forecasting and optimization/ Kamianets-Podilsky Ivan Ohienko National University, 2014 – PP. 32. (203p.) (on Ukrainian)

MATHEMATICAL MODELING DYNAMICS VALUE OF STOCKS Voloshchuk S.D.

Vadym Hetman Kyiv National Economic University, Ukraine
serg_vls@rambler.ru

Stocks as a form of property, are a tool of dividing the profits from the enterprise in a market economy. Stocks value – index of company operation performance. It is possible to simulate dynamic pattern of stocks value using initial-value problem, boundary-value problem and initial-boundary value problem with distributed parameters [1]. In particular, the equation of stock consistency is given by:

$$\frac{\partial u}{\partial t} = \alpha x^2 \frac{\partial^2 u}{\partial x^2} + \beta x \frac{\partial u}{\partial x} + \mu; \int_0^{\infty} u(x, t) dx = N_0, Q(t) = \int_{x_1}^{x_2} u(x, t) dx,$$

where x – value of stock, t – time, $u(x, t)$ – density function shares, N_0 – total number of shares, $Q(t)$ – number of stocks, with a value $[x_1, x_2]$ at time t .

We will solve the problem of modeling the density of shares. Using these parabolic equation and initial-boundary conditions in the discrete form: $u(x_i, t)|_{t=0} = \phi(x_i)$, $x_i > 0$, $i = \overline{1, n}$; $u(x, t_j)|_{x=0} = 0$, $t_j > 0$, $j = \overline{1, m}$.

The problem could be solved approximately. Unknown function construct as the sum $u(x, t) = G(x, t) + u_{0\Gamma}(x, t)$ and there must be a

$$\text{criterion: } \Phi = \sum_{i=1}^n (u(x_i, 0) - \phi(x_i))^2 + \sum_{j=1}^m (u(0, t_j) - 0)^2 \rightarrow \min_{u(x, t)}.$$

$G(x, t)$ – the fundamental solution of the differential equations.

$u_{0\Gamma}(s) = \iint_{(\cdot)} G(x - x', t - t') y_{0\Gamma}(x', t') dx' dt'$ – the function that provides the

satisfaction of initial-boundary conditions. $y_{0\Gamma}(x', t')$ – unknown function. It is found in the process of minimization Φ . The procedure of pseudoinverse the system of integral equations used in this [2].

References

1. Ерофеев В.Т., Козловская И.С. Уравнения с частными производными и математические модели в экономике. – М: Едиториал УРСС, 2004. – 248 с.
2. Скопечкий В.В., Стоян В.А., Кривонос Ю.Г. Математичне моделювання прямих та обернених задач динаміки систем з розподіленими параметрами. – Київ: Наукова думка, 2002. – 361 с.

AN APPROACH TO MODELING OF DECISION MAKING SYSTEMS FOR MOBILE PLATFORMS

Zahorodnii¹ Yu., Voytenko² V.

¹ Taras Shevchenko National University, Ukraine

² Sheridan Institute of Technology and Advanced Learning, Canada

satr@unicyb.kiev.ua, yuzagor@ukr.net ,

volodymyr.voytenko@sheridanc.on.ca

This abstract is related to using mobile applications to enhance decision making [1], [2]. From well-known areas in this case, very popular are:

1. Decision Making in Medicine. Medical applications are increasingly used to support diagnosis and management of diseases. For example, applications that allow the user to input patient-specific information along with reference material to automatically diagnose a disease or condition.

2. Decision Making in Business. These are systems that help a mobile users with decisions that they encounter “on the go”. Examples include consumers making purchasing decisions in retail stores: application read coding information of the product in the supermarket, and suggest the best retailer of this product based on the lowest price in that time.

Another approach could be defined as mobile facilitator in human activity (active mobile helper) with interaction with Nature’s objects. Such application should read information about environment (objects, sounds, specific characteristics) and identify them based on data (similar to mobile expert systems). Objects could be described using mathematical models to help us to find and analyze behavior, structure, or pattern of those objects. Mathematical models include differential equations of different types. For example, it may be the program, which identifies virus’s diseases of culture plants (hop, wheat or another) based on numerical index which can be perceive by mobile device (the plant’s height).

References

1. Mobile Medical Applications.-September 25, 2013, U.S. Department of Health and Human Services Food and Drug Administration, Center for Devices and Radiological Health Center for Biologics Evaluation and Research.
2. Real Time Decision Making and Mobile Technologies, Keith Sherringham (IMS Corp, Australia) and Bhuvan Unhelkar (MethodScience.com & University of Western Sydney, Australia), 2009.

BEST-MEAN ESTIMATES IN MODELS OF INFORMATION CONFRONTATION

Nakonechnyi O., Zinko P.

Taras Shevchenko National University of Kyiv, Ukraine

a.nakonechniy@gmail.com

In the paper, we consider the mathematical model of information confrontation with m types of information [1,3]:

$$\begin{aligned} \frac{dL_i(t)}{dt} &= (a_i + b_i L_i(t)) \left(L_0 - \sum_{i=1}^m L_i(t) \right), L_i(0) = L_i^0 \geq 0, \\ \sum_{i=1}^m L_i^0 &< L_0, 1 \leq i \leq m, t > 0, \end{aligned} \quad (1)$$

where $L_i(t)$, L_i^0 – the current and the initial value of the number of "carriers" of the i – type of information; L_0 – the total number of human society; $a_i, b_i, i = \overline{1, m}$ – intensity distribution of information of the i – type, respectively, the outer and inner channels. Denote $L_i(t, a, b), i = \overline{1, m}$ solutions of the Cauchy problem (1) with given parameters $a = (a_1, \dots, a_m)$, $b = (b_1, \dots, b_m)$.

It is assumed that the points $t_k, k = \overline{1, N}$ ($t_{k+1} > t_k$) are observed values $L_i(t_k, a^0, b^0), i = \overline{1, m}, k = \overline{1, N}$ of the perturbations $v_i(t_k), i = \overline{1, m}, k = \overline{1, N}$, that we know the value

$$y_i(t_k, a^0, b^0) = L_i(t_k, a^0, b^0) + v_i(t_k), i = \overline{1, m}, k = \overline{1, N},$$

where $a^0 = (a_1^0, \dots, a_m^0), b^0 = (b_1^0, \dots, b_m^0)$ – unknown parameters, perturbation $v_i(t_k), i = \overline{1, m}, k = \overline{1, N}$ – are also unknown and belongs

to set $G = \left\{ v \mid \sum_{k=1}^N F_k(v_{1k}, \dots, v_{mk}) \leq 1 \right\}$ for some nonnegative

functions $F_k(x_1, \dots, x_m)$, satisfying conditions $F_k(0, \dots, 0) = 0, k = \overline{1, N}$. Introduce a limited set of the form:

$$Q = \left\{ (a, b) \mid \sum_{k=1}^N F_k(y_1(t_k, a^0, b^0) - L_1(t_k, a, b), \dots, y_m(t_k, a^0, b^0) - L_m(t_k, a, b)) \leq 1 \right\},$$

where $v = (v_{1k}, \dots, v_{mk})_{k=\overline{1, N}}$.

We study the problem [2] of the trajectories and the optimal mean-square projections $\hat{L}(T)$ in accordance $T > t_N$ of the vector $L = (L_1(T, a, b), \dots, L_m(T, a, b))$ with the terms:

$$\begin{aligned} \min_{a,b} \max_{(a^0, b^0) \in Q} \|L(T, a, b) - L(T, a^0, b^0)\|^2 &= \max_{(a^0, b^0) \in Q} \|\hat{L}(T) - L(T, a^0, b^0)\|^2, \\ \min_{a,b} \mu^{-1}(Q) \int_Q \|L(T, a, b) - L(T, a^0, b^0)\|^2 da^0 db^0 &= \\ = \mu^{-1}(Q) \int_Q \|\hat{L}(T) - L(T, a^0, b^0)\|^2 da^0 db^0, \end{aligned}$$

$\mu(Q)$ – Lebesgue measure of the set Q .

References

1. Mihaylov A.P. Model information noyborbyi / A.P. Mihaylov, N.A.Marevtseva // Matematicheskoe modelirovanie. – 2011. – T.23, №10. – Pp. 19 – 32.
2. Nakonechniy O.G. Otsinyuvanny a parametriv v umovah neviznachenosti / O.G.Nakonechniy // Naukovi zapiski KNU ImenI Tarasa Shevchenka, seriya:«Kibernetika». – 2004. – Pp.102 – 111.
3. Nakonechny O.G. Guaranteed estimation of the observations matrix for systems with variable structure // O.G. Nakonechny, V.S. Donchenko, P.M. Zinko / Abstracts XX International Conference “Problem of decision making under uncertainties”. – Brno, Czech Republic. September 17- 21, 2012. – pp. 89–91.

ИНТЕГРАЛЬНОЕ УРАВНЕНИЕ ДЛЯ ВЕТВЯЩЕГОСЯ РЕДУЦИРОВАННОГО ПРОЦЕССА С НЕПРЕРЫВНЫМ ВРЕМЕНЕМ

¹Алиев С., ²Базилевич И.

¹Институт Математики и Механики НАН Азербайджана

²Львовский национальный университет им. И. Франко, Украина

Soltanaliev@yahoo.com, I_Bazylevych@yahoo.com

Рассматриваем однородный неразложимый, непериодический ветвящийся процесс с конечным количеством частиц $\mu(t) = (\mu_1(t), \dots, \mu_n(t))$ с непрерывным временем. $F(t, s) = (F^1(t, s), \dots, F^n(t, s))$ - производящая функция процесса, где

$F^j(t, s)$ - условная производящая функция при условии, что в момент времени $t = 0$ в системе присутствовала одна частица типа j . Процесс $\mu(t, t + \tau)$ мы будем называть процессом редуцированным к процессу $\mu(t)$ - если он обозначает количество частиц в момент времени t , которые имеют в момент времени $t + \tau$ непустое множество потомков.

Введем производящую функцию редуцированного процесса $\Phi(t, \tau, s) = (\Phi^1(t, \tau, s), \dots, \Phi^n(t, \tau, s))$, здесь компонента $\Phi^j(t, \tau, s)$ - условная производящая функция количества частиц типа j имеющих в момент времени $t + \tau$ непустое множество потомков. Также введем еще одну производящую функцию

$$\hat{F}(t, s) = (F_1(t, s), \dots, F_n(t, s)), \text{ где } F_j(t, s) = \sum_{k=0}^{\infty} P\{\mu_j(t) = k\} (s^j)^k.$$

Теорема Производящая функция $\Phi(t, \tau, s)$ удовлетворяет интегральному уравнению

$$\begin{aligned} \Phi^j(t, \tau, s) = & \int_0^{\tau} h^j(\Phi(t-u, \tau, s)) dG_t^j(u) + \\ & + F^j(t, s)(F^j(t, \exp(p_1^j \tau)) - F^j(t, 0)), \end{aligned}$$

где $h^j(s)$ - условная плотность переходных вероятностей частиц типа j при условии, что превращение произошло, $G_t^j(u)$ - функция распределения момента превращения частицы типа j после момента времени t , p_1^j - плотность переходных вероятностей частицы типа j при условии, что превращение не произошло.

Литература

1. Ватутин В.А. Ветвящиеся процессы и их применение/ В.А. Ватутин . - Лекционные курсы НОЦ // Математический институт им. В.А. Стеклова. - Выпуск 8, Москва, МИАН, 2008. – 104 с.
2. Севастьянов Б.А. Ветвящиеся процессы/ Б.А. Севастьянов. - М: Наука, 1971.– 436 с.

ГІЛЛЯСТИЙ ПРОЦЕС З ІМІГРАЦІЄЮ В ТЕОРІЇ ЧИСЕЛ

¹Алієв С.А, ²Бойчук З.Г.

¹Інститут Математики і Механіки НАН Азербайджану

²Львівський Національний університет імені Івана Франка, Україна

soltanaliyev@yahoo.com z_boichuk@yahoo.com

Нехай $m \in [a; b)$, $a, b, m \in N$. В роботі [1] розглянуто означення і властивості цілочисельної величини $SDA(m)$ – кількість додаткових простих дільників числа m , зокрема, якщо p – просте число, то $SDA(p)=0$, $SDA(p^k) = k - 1$.

Означення 1. Системою S означимо усі натуральні числа з інтервалу $[a; b)$ і позначимо $S = [a; b)$

Означення 2. Частинкою m системи S означимо натуральне $m \in [a; b)$.

Означення 3. Тип частинки m визначається числом $SDA(m)$.

Згідно цих означень кожен інтервал $[a ; b)$ на множині N є системою S з типом частинок від 0 і менше $\log_2 b$.

В доповіді побудовано множину станів системи $p_k = [p^{k-1} ; p^k)$, p – просте, $k = 1, 2, \dots$

Спочатку розглянуто випадок $p = 2$: $2_k = [2^{k-1} ; 2^k)$, Очевидно, що при переході системи із стану 2_k у стан 2_{k+1} кількість частинок подвоюється. Доведено, що при цьому кожна частинка типу $SDA(m)$ з ймовірністю 1 переходить в частинку типу $SDA(m) + 1$. Решта 2^{k-1} частинок з невідомими типами іммігрують із зовнішнього джерела.

Розглянуто також випадки гіллястого процесу з імміграцією для довільного простого $p > 2$. При переході системи із стану p_k у стан p_{k+1} кількість частинок-іммігрантів рівна $(p-1) \cdot p^{k-1}$

Для кожної розглянутої системи S_k побудовано закон розподілу величини $SDA(m)$.

Література

1. Boychuk Z.G. The distribution of variable SDA / Z.G. Boychuk// XXII International Conference "Problems of decision making under uncertainties" (PDMU-2013): Abstracts, September 23-27, 2013, Yalta-Foros, Ukraine. – K.: 2013. – С. 15.

ТРАНСФОРМЕРНІ ТЕХНОЛОГІЇ В СКЛАДІ КОМПЛЕКСНОЇ РЕАБІЛІТАЦІЇ З НАВЧАННЯМ ХОДЬБИ

Горбунов О.А., Осадчий Є.О.

Київський національний університет ім.Тараса Шевченка, Україна
gorol21@bigmir.net.

З метою вдосконалення управління процесом комплексної реабілітації в неврології та ортопедії з використанням трансформерного пристрою (ТП), надання допомоги лікарю і персоналу у виробленні правильних рішень, створюється система кібернетичного управління в основу, якої входить медична інформаційна трансформерна технологія (МІТТ).

МІТТ - це сукупність засобів, моделей, алгоритмів і програм, що забезпечують функціонування ТП, як самостійного пристрою, так і як невід'ємного елементу комплексної системи реабілітації, що містить бази даних про пацієнта і бази знань про управління лікувальними впливами; забезпечують супровід всього життєвого циклу ТП.

Створення МІТТ пов'язано також з необхідністю оптимального управління процесом відновного лікування, досягнення найкращих результатів за рахунок ефективного використання всіх функціональних можливостей закладених в ТП. Можна відзначити, що особливістю МІТТ є те, що об'єктом управління є і ТП, і пацієнт (Па), причому і саме ТП є керуючою системою для Па. Крім того, МІТТ містить у своєму складі елементи, що володіють трансформуючими властивостями - досягнення нової мети при їх використанні за допомогою раніше невикористаних властивостей або їх комбінацій. Серед усього арсеналу методів фізичної реабілітації з відновлення рухових функцій цікаві ті, які спрямовані на відновлення ходьби (як окремий випадок відновлення рухових функцій), які застосовуються на всіх етапах лікування.

Розроблений за вимогами МІТТ ТП у вигляді зовнішнього антропоморфного багатофункціонального роботизованого пристрою, відомого як «Exoskelet», відповідає цим вимогам.

НЕКОТОРЫЕ СВОЙСТВА ЦИКЛИЧЕСКИХ ПЕРЕСТАНОВОК КАК ВЕРШИН ПЕРЕСТАНОВОЧНОГО МНОГОГРАННИКА

¹Гребенник И.В., ²Чёрная О.С.

¹Харьковский национальный университет радиоэлектроники,
Украина

¹igorgrebennik@gmail.com, ²titovaolga90@gmail.com

Рассматриваются некоторые свойства подмножеств множества перестановок без повторяющихся элементов и соответствующие свойства образов указанных подмножеств в евклидовом пространстве.

Погружение множества перестановок в евклидово пространство позволяет использовать комбинаторную теорию многогранников для исследования комбинаторных множеств и их выпуклых оболочек – комбинаторных, в том числе перестановочных, многогранников [1].

Различные ограничения в математических моделях задач на множестве перестановок приводят к необходимости введения классов комбинаторных множеств, которые являются подмножествами классического множества перестановок. Одним из таких подмножеств является множество циклических перестановок, для которого комбинаторный многогранник пока не описан. В связи с этим можно использовать перестановочный многогранник для исследования его вершин, соответствующих циклическим перестановкам.

Данная работа посвящена исследованию образов элементов множества циклических перестановок в евклидовом пространстве как подмножества вершин перестановочного многогранника.

Между двумя вершинами перестановочного многогранника, соответствующими циклическим перестановкам, можно указать путь минимальной длины, который в общем случае является не единственным. Определим все возможные пути заданной длины, соединяющие данные две вершины.

В докладе исследуется вопрос определения всех путей, соединяющих две вершины, соответствующие циклическим перестановкам. Подсчитывается количество путей минимальной длины в зависимости от порождающих элементов, задействованных в транспозициях, приводящих к получению смежных вершин перестановочного многогранника.

Литература

1. Емеличев В. А. Многогранники, графы, оптимизация / В. А. Емеличев, М. М. Ковалев, М. К. Кравцов – М.: Наука, 1981. – 344 с.

МАТЕМАТИЧЕСКАЯ МОДЕЛЬ ЗАДАЧИ ПЕРЕДАЧИ ДАННЫХ ПО СЕТИ ОТ НЕСКОЛЬКИХ ИСТОЧНИКОВ ПОТРЕБИТЕЛЮ

Гребенник И.В., Иванов В.Г., Урняева И.А.

Харьковский национальный университет радиоэлектроники,
Украина

**igorgrebennik@gmail.com, valeryivanov@ukr.net,
inna.u2111@gmail.com**

В процессе обмена информацией по сети часто возникает необходимость передать либо скачать файлы большого размера, когда данные находятся одновременно в нескольких доступных хранилищах. Такая ситуация существует в пиринговых (P2P) сетях, реализующих кооперативный обмен файлами через Интернет. Здесь файлы передаются частями, каждый torrent-клиент, получая эти части, в это же время отдаёт их другим клиентам, что снижает нагрузку и зависимость от каждого клиента-источника и обеспечивает избыточность данных. Другими словами каждый файл, который передается в таких сетях, делится на фрагменты и скачивается по частям от разных клиентов в любой последовательности.

При этом возникает возможность, для увеличения скорости закачки, указывать те адреса, откуда можно скачать искомый файл и манипулировать каналами, по которым будет проводиться передача. Это имеет большое значение, поскольку, как правило, скорость соединения потребителя, формирующего запрос, с сетью большая (до 100 Мб в секунду), а на источниках данных обычно устанавливается существенное ограничение по скорости. На разные каналы связи и источники по-разному распределяется загрузка в процессе скачивания. Такой подход позволяет получать высокую скорость загрузки файлов, не зависеть от перерывов соединения, нет необходимости в хранении файла на сервере – файлы могут храниться на компьютерах конечных пользователей.

В работе построена математическая модель задачи планирования закачки файла больших размеров потребителю от нескольких источников за минимальное время как задачи комбинаторной оптимизации. Проведены вычислительные эксперименты с

моделью. При известных параметрах сети – топологии, пропускных способностях дуг, ограничениях скорости передачи и возможных маршрутах спланирована передача файла от источников потребителю за минимальное время. Определены размеры фрагментов, передаваемых из каждого узла, и маршруты следования фрагментов по сети.

ОСОБЕННОСТИ МАТЕМАТИЧЕСКОГО МОДЕЛИРОВАНИЯ ЗАДАЧИ ОДНОМЕРНОГО ПОИСКА В УСЛОВИЯХ СЛУЧАЙНЫХ ВОЗМУЩЕНИЙ

¹Гребенник И.В., ²Ребезюк Л.Н., ²Ребезюк Е.Л.

^{1,2}Харьковский национальный университет радиоэлектроники,
Украина

¹igorgrebennik@gmail.com, ²leonidos_60@ukr.net

При решении задач оптимизации возникает необходимость в решении задачи поиска точки экстремума унимодальной функции в условиях действия случайных возмущений. Известно [1], что процесс поиска точки экстремума унимодальной функции может осуществляться детерминированными методами нулевого порядка.

Случайные возмущения по характеру воздействия на полезный сигнал подразделяются на аддитивные и мультипликативные. Подавляющая часть встречающихся на практике случайных возмущений принадлежит к классу аддитивных. В процессе поиска точки экстремума могут действовать случайные возмущения, искажающие реальное значение унимодальной функции, т.е. будет иметь место случайное блуждание точки экстремума в процессе поиска в исходном интервале, что приводит к искажению информации.

Классические методы одномерного поиска не являются помехоустойчивыми и к настоящему времени не создано методов поиска в условиях действия случайных возмущений, накладываемых на процесс поиска.

В этой связи возникает необходимость в разработке специальных методов одномерного поиска, подавляющих действие случайных возмущений определенного вида и корректирующих случайное блуждание точки экстремума унимодальной функции, которые базируются на алгоритмическом (процедурном) подавлении аддитивных возмущений.

В докладе рассматриваются особенности математического моделирования задачи поиска экстремума унимодальной функции

в условиях действия случайных возмущений на основе анализа общей схемы одномерного поиска в условиях действия случайных возмущений с учетом математической модели случайных возмущений.

Литература

1. Реклейтис, Г. Оптимизация в технике: в 2-х книгах. Кн. 1. Пер. с англ./ Г. Реклейтис, А. Рейвиндран, К. Рэгсдел.– М.: Мир, 1986.– 350 с.

МОДЕЛЮВАННЯ ПРОЦЕСУ РОЗВИТКУ ДЕМОГРАФІЧНИХ ХАРАКТЕРИСТИК ПРАЦЕЗДАТНОГО НАСЕЛЕННЯ

Джалладова І. А., Бабинюк О. І.

ДВНЗ «Київський національний економічний університет
ім. Вадима Гетьмана», Україна
irada-05@mail.ru, sahb@ukr.net

Одним з факторів, що цілком і повністю визначає перспективи розвитку країни є демографія. Багато економік, що розвиваються на власному досвіді пересвідчилися у перевагах демографічного переходу. В таких країнах частка населення працездатного віку, росте, стимулюючи при цьому економічне зростання. Від демографічних характеристик працездатного населення і показників демографічного розвитку залежить розвиток трудового капіталу і, як результат, величина **сукупного національного доходу**.

Припущення згідно з якими будується модель:

1. Вплив чисельності зростання населення на зниження інвестиційного попиту. В сучасних умовах це є дуже актуальною проблемою.
2. Уповільнення зростання кількості населення з одного боку можна вважати благом, оскільки це призводить до зменшення навантаження на ресурси, менший збиток оточуючому середовищу і т. п., з іншого боку при сучасних правилах гри нашим економікам властивий виражений ефект «велосипеду», тобто якщо вони не рухаються достатньо швидко, то падають.
3. Для забезпечення більшої чи менш повної зайнятості, економіка повинна підтримувати витрати на достатньому рівні, щоб використовувати свій потенціал.
4. Важливий компонент витрат – інвестиції – залежить від ефекту прискорення: саме темпи зростання економіки, а не поточний рівень виробництва впливає на попит на новий капітал.

5. Забезпечення достатнього зниження відсоткової ставки, щоб підтримувати інвестиційний попит, незважаючи на сповільнення зростання населення. Проблема в тому, що реальна відсоткова ставка, яка потрібна, за надійними активами може виявитися наприкінці від'ємною і тому, такою, яку можна досягти лише при наявності достатньої інфляції, що вступає в ідеологічне протиріччя з прихильністю забезпечити цінову стабільність.

6. Раціональне використання факторів виробництва з метою підвищення національного прибутку країни є однією з серйозніших проблем, які намагаються вирішити практично всі держави незалежно від їх соціально – економічного розвитку. Тому дуже важливим є розв'язок проблеми з найбільш ефективного використання трудових ресурсів, тобто виявлення оптимальної моделі зайнятості населення. Це питання має дуже важливе значення для України в сучасний період формування основ ринкової економіки. Для української економіки в сучасному стані характерно зростання безробіття, зниження виробничої активності, порушення розподільчих відносин, зростання зайнятості в тіньовій економіці.

7. Для підрахунку рівня безробіття використовуємо методику Бюро трудової статистики: альтернативний індикатор (як доповнення до офіційного). Він відомий під кодом U – 6 і враховує зневірених потенційних працівників, а також співробітників, які зайняті частково, але зволіли б працювати повний день (в офіційній статистиці вони вважаються зайнятими). Розрив між U – 6 та офіційним рівнем безробіття суттєвий (для США U – 6 – 12,3%, а офіційний – 6,3%). Це свідчить про те, що значна кількість робітників працездатного віку, які давно втратили роботу, перестали шукати нові вакансії. Як показали дослідження, ті хто сидить без роботи більше 6 місяців стикаються при працевлаштуванні з великими проблемами, оскільки більшість працевлаштування з великими проблемами, оскільки більшість працевлаштування не хочуть наймати працівників з великими розривами в кар'єрі безвідносної кваліфікації. Тривале безробіття також асоціюється з витратою професійних навичок та зростаючою депресією.

8. Модель враховуватиме також фактор невезіння при тривалому безробітті: якщо когось звільняють під час економічного спаду, то такий людині важко знайти роботу, а чим довше він сидить без роботи, тим важче її знайти. Аналіз О'Брайєна доводить неспроможність альтернативної версії, згідно якої якщо людина не може знайти собі нове місце більш ніж за пів року, то причина в ньому самому.

Література

1. Хансен Е. Економічні цикли та національний дохід, за ред. Хансен Е., М.: Фінансова Академія, 2008. – 466 с.
2. Пол Крутман «Чому економістів турбує чисельність населення», Незалежна газета, 03.06.2014, http://www.ng.ru/krugman/2014-06-03/5_demography.html
3. Пол Крутман «Невдачливі безробітні», Незалежна газета, 03.06.2014, http://www.ng.ru/krugman/2014-06-03/5_jobs.html.

ФОРМАЛІЗАЦІЯ ВЗАЄМНОГО РОЗТАШУВАННЯ ПРЯМОКУТНИКІВ З ВИПАДКОВИМИ ПАРАМЕТРАМИ

Ємець О.О., Барболіна Т.М.

Полтавський університет економіки і торгівлі, Україна

Полтавський національний педагогічний університет

імені В.Г.Короленка, Україна

yemetsli@mail.ru, tn_b@rambler.ru

Однією з практично значимих задач, які можуть бути адекватно формалізовані за допомогою апарату евклідової комбінаторної оптимізації, є задача упаковки прямокутників. У найпростішому випадку вона полягає у розміщенні без накладань у m напівнескінчених смужках однакової ширини p прямокутників такої самої ширини з метою мінімізації найбільшої довжини зайнятих частин смужок.

У випадку, коли параметри прямокутників є дискретними випадковими величинами виникає питання про формалізацію понять взаємного розташування прямокутників. Для цього може використовуватися упорядкування випадкових величин (один із способів введено порядку представлено в [1]). За такого розуміння дотику прямокутників довжина зайнятої частини смужки дорівнює сумі довжин розміщених у ній прямокутників.

Інший підхід до визначення допустимого розташування прямокутників полягає в обмеженні знизу ймовірності неперекриття сусідніх прямокутників. Таке ж обмеження ймовірності накладається при з'ясуванні довжини зайнятої частини смуги. Якщо значення нижньої межі ймовірності покласти рівним одиниці, отримаємо жорстку постановку – прямокутники не мають спільних точок при жодних реалізаціях випадкових параметрів.

Аналогічний підхід може бути також використаний для побудови моделей задач покриття прямокутниками з випадковими

параметрами.

Література

1. Емец О.А. Об упорядочивании дискретных случайных величин / О.А. Емец, Т.Н.Барболина // “Modelare matematică, optimizare și tehnologii informaționale”, conf. intern. (4; 2014; Chișinău). : Materiale Conf. Intern. : Ed. a 4-a, 25-28 mar. 2014, Chișinău / red. resp. : Dumitru Solomon. – Chișinău : Evrica, 2014. – Vol. 2. – Pp. 171-175.

РЕШЕНИЕ ВЫПУКЛЫХ ЗАДАЧ ЛЕКСИКОГРАФИЧЕСКОЙ ОПТИМИЗАЦИИ

¹Ломага М.М., ²Семенов В.В.

¹ГВНЗ „Ужгородский национальный университет”, Украина

²Институт кибернетики им. В.Г. Глушкова НАН Украины, Украина
lomagamarija@yandex.ua, hunt.semen@gmail.com

Рассматривается задача лексикографической оптимизации $\min^L \{F(x) | x \in X\}$, где $F(x) = (f_1(x), \dots, f_l(x))$, $f_k(x)$, $k = 1, \dots, l$, – выпуклые функции. $X = \{x \in R^n | Ax \leq b, x \geq 0\}$, где $A \in R^{m \times n}$, $a_{ij} \in R$, $i = 1, \dots, m$, $j = 1, \dots, n$, $b \in R^m$.

Определение. Вектор $v \neq 0$ будем называть возможным направлением лексикографического спуска из точки x относительно множества X , если $F(x + \alpha v) <^L F(x)$ и $(x + \alpha v) \in X$ при всех достаточно малых $\alpha > 0$.

Предлагается приближенный алгоритм для решения лексикографических задач выпуклой оптимизации, состоящий из трех последовательно выполняемых этапов:

- 1) нахождение возможного направления лексикографического спуска относительно множества X путем решения лексикографической задачи линейного программирования;
- 2) нахождение величины шага в этом направлении решением лексикографической одномерной оптимизационной задачи;
- 3) переход к следующему приближению.

Для решения вспомогательные задачи разработан ряд известных методов[3]. Схема алгоритма:

1. Выбираем допустимое решение задачи x^k . Находим значение $\nabla F(x)$ в точке x^k , где $\nabla F(x)$ вектор, составленный из градиентов частных критериев вектор-функции $F(x)$ в точке $x \in X$:

$$\nabla F(x^k)^T = (\nabla f_1(x^k), \dots, \nabla f_l(x^k)).$$

2. Строим функцию

$$\Phi(x) = \left(\sum_{j=1}^n \frac{\partial f_1(x^k)}{\partial x_j} x_j, \dots, \sum_{j=1}^n \frac{\partial f_l(x^k)}{\partial x_j} x_j \right).$$

Решаем лексикографическую задачу линейного программирования вида: $\min^L \Phi(x)$, $x \in X$. Пусть $z^k = \arg : \min^L \Phi(x)$, $x \in X$. Переходим к пункту 3 алгоритма.

3. Вычисляем $F(x^k)$. Если $(\nabla F(x^k), z^k - x^k) \geq^L 0$, то x^k – точка лексикографического минимума, иначе переходим к пункту 4.

4. Ищем следующее приближение $x^{k+1} = x^k + \alpha_k(z^k - x^k)$, где $\alpha_k : \min_{0 \leq \alpha \leq 1}^L F(x^k + \alpha(z^k - x^k)) = F(x^k + \alpha_k(z^k - x^k))$, и переходим к итерации $k = k + 1$.

Литература

1. Ломага М.М., Семенов В.В. Квадратичні задачі лексикографічної оптимізації: властивості та розв'язання // Комп'ютерна математика: сб. науч. трудов Ин-та кибернетики им. В.М. Глушкова НАН Украины. – 2013. – № 2. – Сс. 134-143.
2. Подиновский В.В., Гаврилов В.М. Оптимизация по последовательно применяемым критериям. – М.: Сов. радио, 1975. – 192 с.
3. Червак Ю.Ю. Оптимізація. Непокращуваний вибір. – Ужгород: Ужгородський національний університет, 2002. – 312 с.

ЗАСТОСУВАННЯ ВДОСКОНАЛЕНОГО МАТЕМАТИЧНОГО МЕТОДУ НА БАЗІ ПОБУДОВИ МАТРИЦІ ПАРНИХ ПОРІВНЯНЬ, ЩО ІСНУЄ У ЗАВДАННЯХ ОПТИМАЛЬНОГО ВИБОРУ ТЕХНІЧНИХ ЗАСОБІВ ОХОРОНИ

Мякухін Ю.В.

ІПМЕ ім. Г.Є. Пухова НАН України, Україна

yuriviti@gmail.com

На наступний час, в умовах складної кримінальної обстановки у світі, а також й в Україні, набуває особливу актуальність впровадження сучасних автоматизованих комплексів технічних засобів охорони (АКТЗО) на складних технологічних об'єктах

енергетики підвищеної небезпеки (СТОЕ). Засоби охорони повинні бути оптимальними для вирішення поставлених цілей і задовольняти існуючим технічним вимогам по забезпеченню безпеки особливо важливих об'єктів енергетики. При цьому СТОЕ варто оснащувати надійними системами безпеки, які задовольняли б науково - обґрунтованим сучасним вимогам.

Для цього був розглянутий і проаналізовано деякий перелік математичних методів, які найбільше б задовольняли технічним завданням, що пов'язані з надійної охороною СТОЕ технічними засобами охорони. За основу пропонується використати наступні математичні методи (всі були удосконалені): критерій Вальда; адитивна функція Бейеса-Лапласа; матриця парних порівнянь; функція Ант'є.

В доповіді пропонується розглянути розроблений удосконалений метод парних порівнянь. Цей метод дозволяє на основі розгляду великої групи значень технічних характеристик розраховувати кількісні оцінки, що характеризують ступені придатності використання розглянутих АКТЗО на заданому об'єкті енергетики. В якості вхідних даних виступають наступні показники: загальна структура АКТЗО (складових елементів, що входять у комплекс); пред'явлені технічні вимоги до АКТЗО, що планується експлуатувати на певному СТОЕ; розгляд деякої сукупності різних АКТЗО; знання множини технічних характеристик кожної АКТЗО.

Розроблений удосконалений метод парних порівнянь планується застосувати для вирішення завдань, зв'язаних з забезпеченням фізичної безпеки СТОЕ з використанням АКТЗО, що передбачений для експлуатації на даному об'єкті. Розроблений новий метод дозволить допомогти проектувальникам, які розробляють певну технічну систему безпеки на заданому об'єкті енергетики на ранніх стадіях проектування. А також допомогти в технічному рішенні вибрати оптимальний варіант і структуру основних елементів АКТЗО й уникнути «людського фактору в проектуванні системи безпеки». Застосування цього математичного апарату дозволить із більшим ступенем надійності впровадити й надалі експлуатувати АКТЗО на СТОЕ підвищеної небезпеки.

ЗАСТОСУВАННЯ МАТРИЧНОГО МЕТОДУ НАЙМЕНШИХ КВАДРАТІВ ДЛЯ ПРОГНОЗУВАННЯ ОБМІННИХ КУРСІВ

Назарага І.М.

Київський національний університет ім. Тараса Шевченка, Україна
inna_na@ukr.net

Обмінний курс є одним із основних показників, що використовуються у макроекономічному моделюванні, а необхідність у міжнародних взаєморозрахунках породжує потребу у надійному його прогнозуванні. У доповіді розглянуто загальні основи методу прогнозного оцінювання показників, що базується на "матричному методі найменших квадратів" (ММНК) із застосуванням псевдообернення за Муром - Пенроузом [1 - 4]. Перевагами ММНК є використання явних формул для оцінок, а також те, що матричні спостереження зберігають структуру зв'язків між досліджуваними характеристиками: як за їх набором, так і у часі. Крім того, у доповіді детально розглянуто покроковий алгоритм застосування методу та представлено результати розрахунків на прикладі прогнозування обмінних курсів. Апробація методу здійснювалася із використанням статистичних даних обмінних курсів грн / долар США, грн / євро, грн / російський рубль за 2009 – 2013 рр. [5].

Для вказаного проміжку часу відповідні розрахунки продемонстрували ефективність запропонованого на базі ММНК підходу до розв'язання задач прогнозування в розглянутій предметній області.

Література

1. Donchenko V.S. Vectors and matrixes least square method: foundation and application examples / Donchenko V.S., Nazaraga I.M., Tarasova O.V. // International Journal "Information Theories & Applications"- 2013. - Vol.20, № 4 - P. 311-322.
2. Donchenko Vladimir S. Matrixes least squares method and examples of its application / Vladimir S. Donchenko, Inna M. Nazaraga, Olga V. Tarasova. // International Journal "Information Technologies & Knowledge". – 2013.– Vol.7.- № 4. – P. 325 - 336.
3. Moore E.H. On the reciprocal of the general algebraic matrix / Moore E.H. // Bulletin of the American Mathematical Society. –1920. – P. 394–395.
4. Penrose R. A generalized inverse for matrices / Penrose R. // Proceedings of the Cambridge Philosophical Society. –1955. – P. 406–413.
5. Офіційний сайт Національного Банку України [Електронний ресурс] – Режим доступу: <http://bank.gov.ua>.

КЕРУВАННЯ З ТОЧКОЮ РІВНОВАГИ ФУНКЦІЇ МЕТИ

¹Нікітін А.В., ²Семенюк С.А., ²Чабанюк М.Я.

¹Буковинський державний фінансово-економічний університет

²Національний університет «Львівська політехніка», Україна

nik_tol@rambler.ru

Теорема. Нехай розглядається процес, що описується стохастичним диференціальним рівнянням

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

з керуванням, що визначається рівнянням

$$du^{\varepsilon}(t) = a(t)G(y^{\varepsilon}(t), x(t/\varepsilon), u^{\varepsilon}(t))dt \quad (2)$$

та складовими $a(u, x, y), G(u, x, y), \sigma(u, x, y) \in C^{2,2,1}(\mathbb{R}^d, X, \mathbb{R}^m)$.

При виконанні умов

$$\int_0^{\infty} a(t)dt = \infty, \quad \int_0^{\infty} a^2(t)dt < \infty$$

має місце слабка збіжність[1]

$$(u^{\varepsilon}(t), y^{\varepsilon}(t)) \Rightarrow (\hat{u}(t), \hat{y}(t)), \quad (3)$$

де граничний процес визначається на тест-функціях

$\varphi(u, x, y) \in C^{3,0,3}(\mathbb{R}^d, X, \mathbb{R}^m)$ генератором

$$L\varphi(y, u) = \hat{a}(y)\varphi'_y(y, u) + a(t)\hat{G}(y, u)\varphi'_u + \frac{1}{2}\varphi''_{yy}(y, u)\hat{\sigma}^2(y, u),$$

де

$$\hat{a}(y) = \int_X a(y, x)\pi(dx),$$

$$\hat{G}(y, u) = \int_X G(y, x, u)\pi(dx), \quad \hat{\sigma}^2(y, u) = \int_X \sigma^2(y, x, u)\pi(dx).$$

Література

1. Korolyuk V.S. Stochastic Systems in Merging Phase Space/ Korolyuk V.S., Limnios N. – :World Scientific Publishing, – 2005. – 330 p.

ТРАНСФОРМЕРНІ ТЕХНОЛОГІЇ В ЗАБЕЗПЕЧЕННІ ЖИТТЄВОГО ЦИКЛУ ПРИСТРОЮ «EXOSKELET»

Осадчий Є.О., Горбунов О.А.

Київський національний університет ім. Тараса Шевченка, Україна
vo_ua@sana.net.ua

В 2004 році вперше в світі була прийнята національна програма США з створення та застосування зовнішнього антропоморфного багатоцільового роботизованого пристрою, що більш відомий як «Exoskeleton». На жаль, до цього часу, не є відомим універсальний пристрій, що без суттєвих конструктивних змін здатен знайти застосування в спортивній, військовій, медичній чи побутовій сферах. Хоча в різних країнах вже існують екзоскелети, що є придатними для масового застосування в окремих з перерахованих сфер. Наш досвід створення та використання екзоскелетів багатоцільового призначення підтвердив перспективність для них, прийнятої нами, архітектурної концепції. Ми їх розглядаємо як пристрої-трансформери. Відповідно, їх життєвий цикл забезпечується застосуванням відповідних трансформерних технологій. По нашому визначенню трансформерам називають «...пристрої, що безпосередньо чи з об'єктами входження мають здатність до перетворення». Тобто, отримують потрібні властивості для досягнення мети. Відповідно, трансформерні технології забезпечують існування трансформера на протязі його життєвого циклу. В якості таких технологій можуть бути використані як унікальні технології, що створюються під конкретний трансформер так і універсальні (ACAD), що можуть використовуватись, в т.ч. на певних етапах життєвого циклу трансформера.

Незалежно від прийнятої архітектурної концепції можна визначити ефективність біомеханічного впливу керованого багатоцільового пристрою класу «Екзоскелет». Вона залежить, по важливості, від рівня гомо логічності, обмеження (підсилення) рухливості, величини навантаження на скелет та складові, ергономіки, рівня роботизації. Останнє, має особливе значення при наявності опорно-рухових порушень. Незалежно від призначення, такий апарат повинен забезпечувати одночасне підсилення та тренування скелетно-м'язової системи і опорно-рухових можливостей.

ОПЫТ РАЗРАБОТКИ И ИСПОЛЬЗОВАНИЯ БАЗЫ ЗНАНИЙ В КОРПОРАЦИИ «NOOSPHERE VENTURES»

¹Поляков М.В., ²Ханин И.Г., ³Шевченко Г.Я.

¹Генеральный директор NV, ²Руководитель Научного Центра NV,

³Руководитель Базы знаний NV, Корпорация «Noosphere Ventures»

¹maxvp77@gmail.com, ²khanin.ig@gmail.com,

³she-genn@yandex.ru

В докладе рассматриваются принципы построения и опыт использования вики-подобной Базы знаний (БЗ) корпорации «Noosphere Ventures». Побудительными причинами (во многом они достаточно традиционны, разве что их приоритет может быть различным) создания такой БЗ в корпорации «Noosphere Ventures» являются следующие:

- Необходимость создания единого информационного пространства в корпорации – диктуется территориальной удаленностью проектов друг от друга и влиянием глобализации (Украина, США, Западная Европа).

- Создание системы эффективного взаимодействия между проектами, (которые выступают как отдельные бизнес - единицы, хотя между ними есть много общего) - диктуется как необходимостью сокращения расходов на однотипные и похожие работы, так и необходимостью повышения степени стандартизации и типизации работ что, как следствие, должно привести к повышению производительности труда.

- Оптимизация расходования средств на обучение и развитие персонала – значительные средства отвлекаются на эти цели, без этого невозможно развитие и финансовое благополучие корпорации – поэтому целесообразно, исходя из этой точки зрения, организовать обучение новым технологиям средствами БЗ.

- Сохранение знаний при уходе сотрудников – изначально традиционная причина создания БЗ.

Приоритетные направления формирования знаний в БЗ определялись направлениями деятельности корпорации, которые связаны, как правило, с различными Интернет-проектами.

При проектировании БЗ использовались следующие методы: структурирования (алгоритмической декомпозиции), системности, абстрагирования, иерархии, модульности, наглядности и простоты.

В докладе выделены и обобщены основные проблемы и задачи, возникшие при построении БЗ корпорации «Noosphere

Ventures»: хранения и аккумуляции знаний, обучения и самообучения в рамках БЗ и с учетом целевых установок ТОП-менеджмента корпорации, корректного общения с БЗ и решения производственных задач, оценки эффективности использования БЗ, поиска в БЗ и создания общего языка – глоссария. В докладе приведены и описаны соответствующие решения.

Рассмотрены основные причины, влияющие на построение и эффективность функционирования такой БЗ. Проведен анализ использования БЗ сотрудниками корпорации, в результате которого выделены основные факторы, влияющие на посещаемость БЗ. Предложена комплексная оценка эффективности функционирования всей БЗ, а также оценка эффективности одной из подсистем БЗ. Предложены пути оптимизации и повышения эффективности БЗ.

Литература

1. Беспалов П. В., Гапоненко А. Л., Корниенко В. И. и др. Интеллектуальный капитал – стратегический потенциал организации. – М.: Социальные отношения, 2003.
2. Брукинг Э. Интеллектуальный капитал. Ключ к успеху в новом тысячелетии. – СПб.: Питер, 2001.
3. Гапоненко А. Л. Управление знаниями. – М.: ИПК Госслужбы, 2001.
4. Джанетто К., Уилер Э. Управление знаниями. – М.: Добрая книга, 2005.
5. Гаврилова Т. А. Базы знаний интеллектуальных систем. – СПб.: Питер, 2000.

ПРО НАДІЙНІСТЬ СИСТЕМИ БЕЗ НАДМІРНОСТІ З ЗАЛЕЖНОЮ ВІДМОВОЮ

Романчук К.Г., Стефанишин Д.В.

Інститут телекомунікацій і глобального інформаційного
простору НАН України, Україна
c.romanchuk@mail.ru, dvstefanyshyn@yahoo.com

Розглядається взаємодія за надійністю двох підсистем (S_M та S_K) у складі єдиної системи S_U без надмірності, яка виконує задану функцію $U: S_U = \{S_M, S_K\}$. При цьому підсистема S_K безпосередньо реалізує функцію U , а S_M забезпечує її виконання.

Нехай відмова системи S_U відбувається при відмові будь-якої з її підсистем, S_K або S_M . Якщо S_K не виконує задану функцію U з власних (внутрішніх), незалежних від S_M причин, таку відмову підсистеми S_K назовемо незалежною. Якщо S_K не виконує функцію внаслідок відмови S_M , то таку відмову S_K назовемо залежною.

Встановлено, що ймовірність відмови системи $S_U = \{S_M, S_K\}$ за відсутності надмірності та з залежною відмовою підсистеми S_K буде більшою за ймовірність відмови аналогічної системи з незалежними відмовами відповідних підсистем S_M та S_K на величину $\Delta p(S_U) = p(S_K)p(S_M) - p(S_K)^2 p(S_M)$, де $p(S_K)$, $p(S_M)$ – ймовірності незалежних відмов підсистем S_K , S_M системи S_U , відповідно.

Показано, що існує межа для нарощування надійності підсистеми S_K , коли без одночасного підвищення надійності підсистеми S_M ймовірність відмови системи S_U зменшуватися не буде і надійність системи S_U не зростатиме.

ЛОКАЛИЗАЦИЯ ОЦЕНОК В МНОГОКРИТЕРИАЛЬНОЙ ЗАДАЧЕ НА МНОЖЕСТВЕ ПЕРЕСТАНОВОК

Семенова Н.В.¹, Нагорная А.Н.²

¹Институт кибернетики им. В.М. Глушкова, Киев, Украина

²Украинский государственный университет финансов и международной торговли, Киев, Украина

nvsemenova@meta.ua, vpn2006@rambler.ru

Довольно часто при моделировании финансово-экономических процессов многокритериальными задачами необходимо, чтобы целевые функции достигали конкретных числовых значений или находились в определенном диапазоне. В большинстве случаев из многокритериальной задачи определенным методом скаляризации получают однокритериальную, для которой известно множество методов решения [1,2]. При этом возможна потеря важных решений. Поэтому актуальной является разработка новых алгоритмов поиска, учитывающих многокритериальность задачи.

Рассмотрим многокритериальную задачу $Z(F, X)$, где $F(f_1, \dots, f_\ell)$, $f_i = \langle c_i, x \rangle \rightarrow \text{extr}$, $i \in N_\ell = \{1, \dots, \ell\}$, и некоторые целевые функционалы должны достигать конкретных числовых значений: $f_1(x) = y_1, \dots, f_k(x) = y_k, k \leq i$, на комбинаторном множестве перестановок $P_n(A)$. Последовательность перестановок согласно лексикографического метода генерирования интерпретируется как граф G_n , вершины которого соответствуют элементам множества перестановок $P_n(A)$ [2,3]. Алгоритм локализации векторной функции для задачи $Z(F, X)$ состоит в следующем:

- целевые функции упорядочиваем по неубыванию приоритетов. Важно исключить те функции, которые попадают в один числовой диапазон, не нарушая содержательность условия задачи.
- Решаем задачу локализации для каждой целевой функции f_i , $i \in N_\ell$, и получаем допустимые множества перестановок G_i [3].
- Нормализуем множества $G_1, G_2, \dots, G_i$, находим общее решение $G' = G_1 \cap G_2 \cap \dots \cap G_i$, $i \in N_\ell$, [4], если оно существует.
- Множество элементов G' упорядочим в лексикографическом порядке неубывания и получаем множество искомых решений задачи $Z(F, X)$. Дальнейшие исследования будут направлены на рассмотрение многокритериальных задач на других комбинаторных множествах.

Литература

1. Сергиенко И.В., Каспшицкая М.Ф. Модели и методы решения на ЭВМ комбинаторных задач оптимизации. – К.: Наукова думка, 1981. – 288 с.
2. Семенова Н.В., Колечкина Л.М. Векторні задачі дискретної оптимізації на комбінаторних множинах: методи дослідження та розв'язання. – Київ: Наук. думка, 2009. – 266 с.
3. Донец Г.А., Колечкина Л.Н. Об одном подходе к решению комбинаторной задачи оптимизации на графах // Управляющие системы и машины. – 2009. – № 4. – Сс. 36–42.

СТЕНДИ НАПІВНАТУРНОГО МОДЕЛЮВАННЯ ДЛЯ СТВОРЕННЯ СКЛАДНИХ СИСТЕМ

Тимашов О.

Інститут кібернетики ім. В.М. Глушкова НАН України, Україна
alex_timashov@mail.ru

Наукові, організаційні та технічні проблеми, пов'язані з проведенням випробувань складної техніки за своєю складністю сумірні з проблемами створення самих виробів

Напівнатурне моделювання дозволяє уточнити результати аналітичних розрахунків при проектуванні систем, їх математичного моделювання, а також скоротити обсяг коштовних натурних випробувань [1]. Якщо математичне моделювання найбільш ефективно на ранніх стадіях проектування системи, натурне - на завершальних, то напівнатурне моделювання зазвичай використовується на проміжних стадіях. Після виготовлення розробленого зразка, в ряді випадків проведення натурального моделювання утруднене або взагалі неможливо, тому що алгоритми управління системою та обробки сигналів ще не налагоджені. Перехід від етапу комп'ютерного моделювання до реалізації в "залізі", мабуть, є найважчим. Це пов'язано, в першу чергу, з тим, що ніяка математична модель, наскільки б точною вона не була, не здатна врахувати всіх особливостей системи. Саме в цьому випадку на перший план виходять методи напівнатурного моделювання. У процесі напівнатурного моделювання вдало поєднуються переваги математичного та натурального моделювання, і може бути досягнуто оптимальна взаємодія між обчислювальними і натурними експериментами.

Дослідження реальних точностних характеристик системи, що розробляється, у всьому діапазоні можливих змін параметрів, зовнішнього впливу і розробка на цій основі оптимальних алгоритмів обробки даних та керування - все це можливо тільки з використанням стендів напівнатурного моделювання.

Література

1. A. Brandt, I. Kossev, Albert Falke etc., Preliminary system simulation enviroment of the university micro-satellite Flying Laptop. In book: R. Sandau etc. Small Satellites for Earth Observation, 2008, 342 p.

МІНІМАКСНЕ ОЦІНЮВАННЯ В ГІПЕРБОЛІЧНИХ РІВНЯННЯХ З РОЗРИВНИМИ КОЕФІЦІЄНТАМИ ПРИ НЕПОВНИХ СПОСТЕРЕЖЕННЯХ І ФУНКЦІЯ ДЖЕРЕЛА ЗАЛЕЖИТЬ ВІД ПРОСТОРУ

Чухрай Л., Чухрай В.Є.

Львівський національний аграрний університет, Україна

l.chukhrai@gmail.com

В $\Omega_t = \{(x, t) : 0 < x < 1, t_1 < t < t_3\}$ розглянемо гіперболічну крайову задачу

$$a(t) \frac{\partial^2 \varphi(x, t)}{\partial t^2} = \frac{\partial}{\partial x} \left(k(x) \frac{\partial \varphi(x, t)}{\partial x} \right) + b(x) \varphi(x, t) + B(x, t) f(x) \quad (1)$$

з крайовими умовами

$$\varphi(0, t) = 0, t \in (t_1, t_3), \quad \varphi(1, t) = 0, t \in (t_1, t_3) \quad (2)$$

та початковим умовами

$$\varphi(x, t_1) = f_0(x), \quad \varphi'(x, t_1) = w_0(x), \quad x \in (0, 1), \quad (3)$$

де $f(x) \in L_2(0, 1)$, $f_0(x) \in L_2(0, 1)$, $w_0(x) \in L_2(0, 1)$, $B(x, t) \in C(\Omega_t)$,

$k(x) \in C^1(0, 1)$, $b(x) \in C(0, 1)$, причому $\exists \alpha > 0, c > 0$ таке, що $k(x) \geq \alpha > 0, k(x) \leq c$ майже скрізь на $(0, 1)$, а коефіцієнт $a(t)$ задовольняє умову

$$a(t) = \begin{cases} a_1, & t_1 < t < s, \\ 0, & t = t_2, \\ a_3, & t_2 < t < t_3, \end{cases} \quad (4)$$

де $a_1(t) \in L_2(t_1, s)$, $t_1 < s < t_2$, $a_3(t) \in L_2(t_2, t_3)$, $a_1(t) > 0, a_3(t) > 0$.

Припускається, що спостерігається реалізація випадкового процесу $y = (y_1(t), y_3(t))$ з гільбертового простору H у вигляді

$$\begin{cases} y_{1k}(t) = \int_0^1 h_k(x) \varphi_1(x, t) dx + \eta_{1k}(t), & t_1 < t < s, k = \overline{1, N_1} \\ y_{3k}(t) = \int_0^1 h_k(x) \varphi_3(x, t) dx + \eta_{3k}(t), & t_2 < t < t_3, k = \overline{1, N_3} \end{cases} \quad (5)$$

де $\varphi(x, t) = (\varphi_1(x, t), \varphi_2(x, t), \varphi_3(x, t))$ - узагальнені розв'язки системи рівнянь (1)-(4), $h_k(x) \in L_2(0, 1)$, $i = 1, 3$, $\eta_{1k}(t), \eta_{3k}(t)$ - вибіркові значення випадкових процесів, які попарно некорельовані, з нульовими математичними сподіваннями

$M\eta_{1k}(t) = M\eta_{3k}(t) = 0, M\eta_{1k}^2(t) < \infty, M\eta_{3k}^2(t) < \infty$. Будемо вважати, що $f_0(x), w_0(x), f(x), \eta_{1k}(t), \eta_{3k}(t)$ не визначені точно, а відомо, що вони належать множині

$$\int_0^1 (f_0^{(n)}(x))^2 q_0^2 dx + \int_0^1 (w_0^{(n)}(x))^2 q_{00}^2 dx \leq 1,$$

$$\int_{t_1}^s M\eta_{1k}^2(t) r_{1k}^2(t) dt \leq 1, \int_{t_2}^{t_3} M\eta_{3k}^2(t) r_{3k}^2(t) dt \leq 1,$$

Знайдено мінімаксну оцінку функціоналу $l(\varphi)$

$$l(\varphi) = \int_{t_1}^s \int_0^1 l_1(x, t) \varphi_1(x, t) dx dt + \int_0^1 l_2(x) \varphi_2(x) dx + \int_{t_2}^{t_3} \int_0^1 l_3(x, t) \varphi_3(x, t) dx dt \quad \text{за}$$

неповними спостереженнями (5) за станом системи, що описується системою рівнянь (1)-(4) у наступному вигляді

$$\hat{l}(\varphi) = \int_0^T \hat{u}(t) y(t) dt = l(\hat{\varphi}),$$

при цьому похибка оцінювання дорівнює

$$\sigma^2 = \sup_{G_0} M[l(\varphi) - \hat{l}(\varphi)]^2 = l(p)$$

$$\text{а } \hat{u}(t) = \left(\int_0^1 r_1^2(t) h_1(x) p_1(x, t) dx, \int_0^1 r_3^2(t) h_3(x) p_3(x, t) dx \right).$$

Функція $p(x, t)$ однозначно визначається як розв'язок системи інтегрально-диференціальних рівнянь.

Література

1. Наконечний О.Г. Оцінювання параметрів в умовах невизначеності // Наукові записки КНУ ім.Т.Г.Шевченка. — 2004.- Том 7: факультет кібернетики. — С.102-112.
2. Наконечний О.Г. Оптимальне керування та оцінювання в рівняннях із частинними похідними. Навчальний посібник – ВПЦ «Київський університет», 2004.

РІВНЯННЯ БЕЛМАНА В ЗАДАЧАХ ОПТИМІЗАЦІЇ МНОЖИН ПОЧАТКОВИХ ЗНАЧЕНЬ ДЛЯ СТОХАСТИЧНИХ РІЗНИЦЕВИХ РІВНЯНЬ З МАРКОВСЬКИМИ КОЕФІЦІЄНТАМИ.

Шушарін Ю.В., Салімова Н.А.

Київський національний економічний університет імені Вадима
Гетьмана, Україна
shusharin@meta.ua

Розглядаються векторні різницеві рівняння вигляду

$$X_{k+1} = A(k, \xi_k)X_k + \sum_{j=1}^r B_j(k, \xi_k)X_k \eta_{kj} + B(k, \xi_k)u_k, \quad k = 0, 1, \dots, \quad X_0 = v_0,$$

де $A, B_j, j = \overline{1, r}, B$ – деякі матриці, ξ_k – послідовність векторних випадкових величин, що утворюють ланцюг Маркова із скінченним числом станів $\theta_1, \dots, \theta_q$, $\eta_{kj}, k = 0, 1, \dots, j = \overline{1, r}$ – скалярні випадкові величини, що не залежать від ξ_k , u_k – вектор керувань, що вибирається у вигляді $u_k = F_k(X_k, \xi_k)$, де F_k – деяка функція. Нехай $G(\lambda)$ множини початкових значень v_0 , така що виконується умова

$$v(u) = \sum_{k=0}^{T-1} E g_k(X_k, u_k) + g_T(X_T) \leq 1, \quad (1)$$

λ – скалярний параметр, $g_k, g_T, k = \overline{0, T-1}$ – деякі s -однорідні функції. Позначимо через $G(\lambda_{\max})$ – максимальну по включенню множину, при якій виконується умова (1).

Показано, що при деяких умовах має місце рівність

$$\max_{u_0, \dots, u_{T-1}} \lambda_{\max} = \left[\sup_{G(1)} V_0(v_0) \right]^{1/s},$$

де $V_0(v_0) = \sum_{n=1}^q V_{n,0}(v_0)q_n$, $q_n = P\{\xi_0 = \theta_n\}$, а функція $V_{n,t}(x)$ є розв'язком рівняння

$$V_{n,t}(x) = \min_u \left[g_{t,1}(x, u) + \sum_{l=1}^q EV_{l,t+1} A(n, \theta_l) X + \right. \\ \left. + \sum_{j=1}^r B_j(n, \theta_l) X \eta_{nj} + B(n, \theta_l) u \right] \pi_{l,n},$$

де $\pi_{l,n} = P\{\xi_{t+1} = \theta_l / \xi_t = \theta_n\}$, $V_{n,0} = g_1(x)$.

Література

1. Коренівський Д.Г. Стійкість розв'язків систем різницевих рівнянь при стохастичних збуреннях їх коефіцієнтів. Алгебраїчні критерії / Коренівський Д.Г. // Київ: Ін-т математички НАН України, 2010.—210 с.
2. Шушарін Ю.В. Дослідження стійкості розв'язків системи лінійних стохастичних диференціальних рівнянь з марковськими коефіцієнтами / Шушарін Ю.В. // Обчислювальна та прикладна математика, 2011, — №3 — С.183 — 189.

Наукове видавництво ТВіМС
Свідоцтво ДК 110 від 5.07.2000 р.
у Державному реєстрі видавців, виготовників
і розповсюджувачів видавничої продукції
03127, м.Київ, пр. Глушкова, 2

NOTES