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ABSTRACTS

Editors: Yu.E. Malashenko, N.M. Novikova

The conference is conducted by Russian Scientific Operations Research Society, Russian Academy of Sciences (Computing Center of RAS), and Moscow State University (Faculty of Computational Mathematics and Cybernetics, Operations Research Department). It is sponsored by the Russian Fund for Basic Researches (grant No.98-01-10086) and hosted by Computing Center of RAS. Computing Center is the oldest research center in Russia in the field of computational methods and decision support systems. The conference is devoted to theoretical aspects and applications in operations research.

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SECTIONS

Plenary: Plenary session
MDM: Multiple objective decision making
ESMB: OR in economic, sociology, medicine, and biology
F: OR in finance
OM: Optimization methods in OR (nonlinear case)
LP: Linear programming
DO: Discrete optimization
N: Networks and data processing
GT: Game theory
GA: Applications of game theory
MT: Mathematical tools of OR

Competitive Equilibrium in Economics as a Kind of Complementarity Problem

E.V. Avtukhovich
(Russian Peoples' Friendship University)

We consider some examples in which the complementarity problems are arised. The problem of competitive equilibrium existence is reduced to the complementarity problem. The existence theorem of complementarity problem solution is obtained for set-valued mappings. This is a generalization of Kalashnikov's theorem in the case of set-valued maps. The result is given as alternative: first, a problem solution exist or second, an exclusive set of points exist. The theory of variational inequalities is used to prove the existence theorem of complementarity problem solution in the case of the upper semicontinuous mappings.

The research is supported by grants N.N. 96-01-00664 and 98-01-00777 of RFBR and grant "Scientific school" N. 96-15-96207.

Some Applications of Signal Processing in Communication, Tracking, and Hybrid System Analysis

Andrey E. Barabanov
(St.-Petersburg University)
Bibliotechnaya pl.2, Stary Petergof, 198904 St.-Petersburg, Russia,
Andrey.Barabanov@pobox.spbu.ru

1. A new parallel-type modem algorithm and program were developed. The linear part and the channel were analyzed in accordance with the Russian standards (Order N 50). An accuracy of the cut filter was established, adaptation of the cut filter and the equalizer were added. The same was done for the standards V22 and V29.

2. A new half-rate (5.6 kbps) full spectral vocoder was designed. It contains: the Levinson-Durbin algorithm (GSM, Nokia), the thrifty coding of the linear prediction coefficients (Nokia), fast computation of the integer pitch period using the FFT subroutine (MBE), a restoration by weighted cosines (MBE).

3. A recognition of particular sounds in the speech signal was made by its spectral analysis. A table of locations of the 3–5 first formants was created for Russian sounds. The maximum likelihood approach is used for the speech recognition.

4. An emulator of the radar ship tracking system is developed as a real-time program on PC Pentium-300. The input is the standard radar signal and the output map satisfies the IMO standards.

5. Large-scale model of a car diesel engine. This hybrid system contains EGR, cooler, exhaust and intake manifolds, transmission and other subsystems. An approach of its reducing to the entirely logical Petri Nets is proposed.

Optimal Stopping Rule for a Sequence of Additive Markov Chains

V.M. Bocharov
(Volgograd State University)

Let us define *additive Markov chain* as follows:

$$S_0 = 0; S_n = S_{n-1} + x_n, \quad n = 1, 2, \ldots,$$

where x_n are independent stochastic discrete values, x_n assumes value $a_i \in N$ with probability $p_i, i = \overline{1, m}$. p_0 is the probability of absorption. If the latter occurs, the process stops and the result sum assumes zero value, $S = 0$. If the process is not absorbed, we can stop it on each step n, the result sum S assuming value S_n.

We suppose that $\sum_{i=0}^{m} p_i = 1$, $1 \leq a_1 < a_2 < a_3 < \ldots < a_m$.

The distribution function determined by a pair of sets $A = \{0, a_1, ..., m\}$, $P = \{p_0, p_1, ..., p_m\}$ is denoted as $\mathcal{P}$. The additive Markov chain with distribution function Pis referred to as $\mathcal{M}(\mathcal{P})$.

Statement of purpose. We suppose that there are a sequence of K different additive Markov chains $\mathcal{M}(\mathcal{P}_1), \mathcal{M}(\mathcal{P}_2), \ldots, \mathcal{M}(\mathcal{P}_K)$, each of those results with a sum $s_i, i = \overline{1, K}$. What strategy maximizes the probability of the event $\{s_1 + ... + s_K \geq n\}$, where $n \in N$ is a given number?

Results. The class of strategies is introduced. An algorithm of finding optimal strategy in this class is constructed.

Algorithm for Approximation of Feasible Sets in Criterion Space in Linear Problems with a Large Number of Decision Variables

L.V. Bourmistrova
(Moscow State University)

Results of an experimental study of a new algorithm (converging polyhedron algorithm, CPA) for approximation of the feasible sets in criterion space (FSCS) are described. The algorithm approximates convex FSCS by a sequence of polytopes. The algorithm is especially effective in the case of linear decision problems with a large number of decision variables. Properties of the CPA were studied, constants that characterize the rate of convergence of the algorithm were evaluated on the basis of data obtained in approximation experiments with different bodies. Experiments supported the theoretical result that the CPA is an optimal algorithm from the point of the convergence rate. The research proved that the CPA can be used as a part of multiple criteria decision support systems instead of currently used algorithms.

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Asymptotic Properties of Models of Adaptive-Imitative Behavior

A.S. Boyko
(Moscow State University, OR Dept.)

A model of adaptive-imitative behavior is described by the following equations:

$$\dot{\pi}_i = -r_i \pi_i \sum_{l:f_i > f_i} q_{il}\gamma_{il} + \sum_{l:f_l < f_i} r_l \pi_l q_{li} \gamma_{li}$$

where π_i is a part of players playing strategy i;

$r_i = r_i(f(\pi), \pi)$ is a rate of transition to adaptive state;

$q_{il} = q_{il}(f(\pi), \pi)$ is the probability for a person playing strategy i to choose strategy l as option after transition to adaptive state;

$\gamma_{il} = \gamma_{il}(f(\pi), \pi)$ is conditional probability of transition from strategy i to strategy l.

We have found suffient conditions for truth of the following statements:

1. Every stable distribution is Nash equilibrium.
2. Every strict equilibrium is asymptotically stable.
3. For every strict dominating set $J' \subset J$, if $j \in J'$, then $\pi_j(t) \to 0$ as $t \to \infty$.

They contains in two theorems:

Theorem 1. Let in the model of adaptive-imitative behavior, functions r_i, q_{il}, γ_{il} be continuous w.r.t. π, functions r_i bounded from below by constant $m > 0$, $q_{il} > 0$ $\forall l \in \mathrm{Argmax} f_i(\pi)$, functions γ_{il} dependent only on the difference $f_l(\pi) - f_i(\pi)$, and $\gamma() > 0$ as the argument is greater than zero. Then statements 1 and 2 are true for this model.

Theorem 2. Let in the model of adaptive-imitative behavior, functions γ_{il} be dependent only on the difference $f_l(\pi) - f_i(\pi)$, functions γ_{il} increased, $r_i = r_j = r$ $\forall i, j$, function r increased in f_i $\forall i$, function r bounded from below by constant $m > 0$, $q_{il} = \pi_l$ and there $\exists M : \forall \pi$, $\forall i$ $|f_i(\pi)| \leq M$. Then statements 1 and 3 are true for this model.

The research is supported by grant N. 96-01-00999 of RFBR.

Model of Interaction between Pollution and Nature

A.S. Bratus and A.B. Mescherin
(Moscow State University)

We want to suggest the comparatively new ecological model of pollution's spreading. The main idea of this model is interaction between pollution and environment. Let us place a source of pollution in some natural environment. At the beginning, assume that pollution comes in discrete units. Nature then absorbs certain quantity of the pollutant. Pollution, in its turn, makes fatal influence to the nature. To describe

this interaction we introduce the conceptual model, which is based on real experiments. Then the model extends to differential model. And we get the Lotka-Volterra equation for two competing species.

$$\begin{aligned} \dot{x} &= a - gx - cxy \\ \dot{y} &= by - ry^2 - dxy \end{aligned} \tag{1}$$

or after transformation

$$\begin{aligned} \dot{x} &= \alpha x - x - xy \\ \dot{y} &= (x_0 - x)y - py^2 \end{aligned} \tag{2}$$

With different parameters three cases are possible:

1. There exists a unique fixed point, which is a global attractor. Pollution remains at a fixed level due to absorption by nature.

2. Bistable situation with three fixed points, two of them is also an atractors, and one is saddle (repeller).

3. Finally, at high pollution we have one global attractor that corresponds to complete pollution, i.e. death of nature.

This model describe the regularity in rise of this cases. Also we consider the distributed model on the plane. That system can be solved by numerical simulation and there exist graphical results. In this way there are many open question and opportunity to develop the model.

On Methods of Solving Linear Programming and Game-Theoretical Problems of Large Dimensions

L.M. Bregman and I.N. Fokin
(Institute for Industrial Mathematics, Israel),
(Institute for Economics and Mathematics of RAS, St.Petersburg)

The aim of this report is to present an algorithm for efficient solving linear programming problems with small rank of restrictions matrices and to describe the classes of non-cooperative games for which such an approach is admissible. This algorithm is the generalization of the column generation technique for solving linear programming problems for which matrices of constraints have very much numbers of both variable and constraints and the rank of these metrices is significally smaller than its dimensions. The various classes of non-cooperative games can be converted to linear programming problems with restictions matrix of considered type. The method under consideration give opportunity to find equilibrium points in such games.

We introduce a class of non-cooperative games – separable games, which can be reduced to linear programs with non-full rank matrices. Such problems can be described by means of polymatrix games, games with degenerated payoff functions and resources allocation game-theoretical problems. Some opportunity of applications of suggested

methods to solving some compositions of economic-mathematical models are considered.

On the Developing of Simulation Center in the Internet

YU. BRODSKY
(Computing Center of RAS, Moscow)

The burst growth of Internet and Intranets during last years made up the new worldwide information area with inexhaustible resources which are accessible from almost any PC. The problems of simulation of complex technical and construction systems are still topical, as they help to find out "bottle necks", to compare different realizations of complicated technical projects as early as the stage of system projecting begins, and to train the personal early before the whole system is built.

The researches carried out last years in the Simulation Modeling department of Computing Center of Russian Science Academy in the field of developing of concepts and instruments for complicated systems modeling let us now begin the new step in evolution of simulation instruments — developing of the simulation center in the Internet. The principle base of such center should be instrumental systems of simulation, elaborated in Simulation Modeling department of CCAS and the corporative network of CCAS with it's connection to the Internet. The two main applications of such a center we see now, are:

- developing of spread simulation systems;
- serving the remote clients in simulation experiments.

In both of these applications we have some experience in Simulation Modeling department.

Application of Numerical Methods for Solving the Tasks of Optimal Portfolio Creation

N.N. BUREEVA and O.V. PETROVA
(University of Nizhni Novgorod, Faculty of Management and Entrepreneurship)

The creation of the optimal portfolio is one of the main problems concerning the process of investment. Markovitz's theory is one of the approaches from the modern theory of capital investment for solution the task of optimal portfolio creation. According to this theory it's not necessary for the decision maker to estimate all the possible portfolio. It's sufficient to consider only so-called effective set of portfolio.

We consider the model in our paper that is the advanced Markovitz model. Let us have N different kinds of securities. We would like to create the optimal portfolio which consists of m kinds of securities ($m < N$). The case when $m = N$ was described by Markovitz in his theory.

The aim of the article is to show the solution of the above task of optimal portfolio creation using the numerical methods and different criteria of selection. Results that were obtained with use of the numerical methods are in accordance with the theoretical conclusions. The specific examples are based on the real data.

Resource Allocation with Saturation

A.P. Cherenkov
(Computing Centre of RAS)

We consider problems of optimal resource allocation with saturation. Resources are allocated over a continual or discrete set. Depending on it we distinguish continual and discrete problems. But we always believe that resources are continuous. The used mathematical methods are suitable predominantly for of continual problems. Information about conditions of resource allocation may be known, random, uncertain. It may be two sides with their resources. The resultant effectiveness of allocation is determined through effectivenesses in the separate points. The functions under consideration may be not smooth. Use of specific properties of our problems permits to develop and apply peculiar methods of investigation. Lexicographical variables are introduced, it permits to consider a strict monotone continuous function instead of a monotone non-continuous and with constancy intervals function. For finding solutions we use some special principles. Using necessary conditions of optimality, parametrization we receive a quality form of the solution. The dimension of the problem is essentially decreased. The solution is obtained in an analytical, generally implicit, form. We find the global solution and, if exact, then general. Reasons of solution non-uniqueness are investigated. Methods of continual problems solution are used to solve analogous discrete problems.

Multiple Aggregation of Constraints in Multistage Stochastic Programming

M.R. Davidson
(Moscow State University)
e-mail: davidson@ccas.ru

In the talk, we discuss a regularized constraint aggregation method with application to solving a multistage stochastic linear problem. Problems of this kind arise in decision making under uncertainty. The process is modeled as a sequences of stages. At each stage a decision maker observes the previous decision history and realization of stochastic process and chooses the best action in terms of the goal function. A practical size linear multistage stochastic problems reduce to a large-scale structured linear programs which are solved with the aid of certain decomposition techniques. Constraint aggregation techniques

proposed allows one to decrease the number of constraints and to choose. the aggregation scheme so that to reflect the problem's structure. In particular, the reduced problem may have a similar structure as that of the original problem — thus, decomposition techniques may be applied for the reduced problem.

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Iterative Approximation for Convex Optimization Problems with Operator Constraints in Hilbert Space

M.R. Davidson and N.M. Novikova
(Computing Centre of RAS)

We consider a problem of minimizing an integral functional in Hilbert space subject to operator inequality constraints. We are interested in finding both optimal value and optimal solution of the problem. In the paper, a method of iterative approximation is proposed that reduces the original problem to a sequence of semi-infinite optimization problems. For those a prox-regularized method of constraint aggregation is considered. Based on this scheme, combined with iterative increase of the approximation order, a deterministic and stochastic numerical algorithms for the initial problem are developed. The convergence of the algorithms is proved for a convex case. The stochastic algorithm is proved to converge with probability 1.

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Optimal Marketing Strategy Problem

D.V. Denisov, A.V. Timokhov, and D.A. Timokhov
(Moscow State University)
Dmitry V. Denisov, Associate Professor, denisov@cs.msu.su,
Alexander V. Timokhov, Chief of Laboratory of imitation modelling
and business simulaton, timokhov@vkkb.srcc.msu.su,
Dmitry A. Timokhov, student.

Consider a consecutive process of production sales of some goods. Suppose that value production at any moment of time $t, t = 0, 1, 2 \ldots$ depends on results of sales at preceding moments and these results depend on some external parameters, prices per unit of our goods and advertisment expenses. At the begin of the process we have some bank loan, on the base of which it is possible to begin production of the goods and marketing process. In this model it is necessarry to determine the optimal value of the rest of the cash at a fixed moment T. So this problem may be formulated as a dynamic programming problem. We assume, that production cost of y units of goods at the t-th moment is $c^t(y)$ and the cost of goods unit is $\bar{c}^t$, f^t is a rest of cash, f^0 is a value of a bank loan

at the beginning moment $t = 0$. Value $f^0 = c^0(y^0) + b^1$, y^0 is a number of goods units producted at the begin of process, b^t is the upper bound of advertisment expenses at a moment t and this value is assigned at a moment $t-1, t > 0$. If x^t is a number of goods store at a moment t, then $x^1 = y^0$ and for other t we have $x^{t+1} = x^t + y^t - s^t$, value of parameter s^t is a goods sales. The advertisment expences at a t-th moment $a^t \leq b^t$, for each t value $b^t = f^{t-1} - c^{t-1}(y^t)$ and for $\bar{c}^t$ recurrent formula is

$$\bar{c}^{t+1} = \bar{c}^t + (c^t(y^t) - \bar{c}^t y^t + a^t)/x^t,$$

$\bar{c}^1 = c^0(y^0)/y^0$. If p^t is a price per unit of goods, $d^t(p^t, a^t)$ is a demand value at a moment t, then $s^t = min(x^t, d^t(p^t, a^t))$,

$$f^t = (p^t - \bar{c}^t)s^t + b^t - a^t.$$

Now for a moment T it is necessary to find maximum of value f^T and corresponding optimal traectory $p^t, a^t, b^t, x^t, y^t, s^t, f^t, t = 1, 2, \ldots T$. The control parameters are p^t, a^t, b^t and others are the phase parameters. At the same time the functions $c^t(y), d^t(p, a)$ are considered as external parameters.

It is possible to write analytical expressions for Bellman fuctions of this problem in some important cases. For example, when $d^t(p, a)$ are decreasing concave or linear functions of p for each a we can write these expressions.

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Optimal Bond Portfolios in Yield-Duration Space

Andrey A. Dirotchka and Ivan S. Menshikov
(Moscow Institute of Physics and Technology),
(CC RAS, FAST-Center of Academy of National Economy).

This paper discusses one of contemporary problems in asset management bond portfolio investments. Investor is to make a choice among various types of bonds traded on stock market. Problems arising in real life are quite complex; it is not feasible to build a reasonable model comprising all relevant factors. This is the reason why we have to limit our scope of view to some parameters; thus, two-parameter model of bond portfolio was developed. In such model we assumed that single investor is interested only in yield and duration of the portfolio, maximizing his outcome (or yield) with duration fixed.

Fortunately, the optimization problem brought by the model could be reduced to well-studied linear programming tasks. Furthermore, portfolio with optimal yield and given duration could be build with only two bonds; this statement has been proofed as a theorem. Moreover, only a small part of bonds traded forms optimal portfolios. Applied these

results, we described a set of all portfolios that could be built with bonds from the market. Some numeric procedures written on Excel perform search of optimal portfolios.

Studies done may faciliate creating investment strategies; besides, portfolio optimality could help to conceive market situation.

A First-Price Auction Model with a Fictitious Buyer

N. Durakovich and S.V. Somov
(Moscow State University, OR Dept.)

This paper studies a first-price auction model with a fictitious buyer. The payoff of the fictitious buyer coincides with the seller's one. Every buyer is characterized by his reserve price. He resells the bought good at this price. All buyers and the seller maximize their income.

We consider the auction model as a two-stage game, where players are the buyers and the seller (together with the fictitious buyer). A strategy of each player is his bid price and the payoff equals to the income from the difference between his bid and reserve prices. The payoff of the fictitious player is the seller's payoff and it is equal to the income from the difference from all auction sells between the sell and the start prices. At the first stage, the fictitious buyer sets his bid and at the second stage, all other buyers set their bids independently and simultaneously.

We use the dominance elimination procedure in order to find an optimal behavior of the buyers at the second stage of the model. The outcome of the auction is found for any strategy of the fictitious player. Then, we optimize the seller's income by choosing the fictitious player's strategy. Our result shows that the fictitious player can choose any price bigger than the equilibrium price and supply such amount of the good that all other players with reserve prices bigger than this price set their bid prices equal to the fictitious player's price. By solving the optimization problem, we find the optimal fictitious player's strategy. The optimal price is a monopoly price for the one-good market.

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Decision Making Models for Trading in Financial Markets Based on the Methods of Technical Analysis

N. Evtikhiev and A. Shenets
(Operations Research Department, Moscow State University)

This work is devoted to the problem of financial market analysis and decision making. We discuss the task of maximization of the total net profit of the investor that invests the initial capital in different types of securities. We investigate the model of the monoportfolio management, this means that the investor invests all his capital only in one security. At any moment the investor has to choose among three strategies to follow: to buy a security, to sell it or to keep a cash position. So the decision making model should help the investor to choose the correct strategy analyzing the time series of the securities prices.

To solve this problem we used some methods of technical analysis of the financial market. We developed a new indicator based on the combination of a well–known Moving Average Convergence–Divergence Histogram (MACD–Histogram) and a new volume–based oscillator. This indicator was called VBBS. On the basis of VBBS there was built a trading system that gives buy/sell signals to the investor by analyzing the previous movements of the securities prices and trade volume. The unique feature of this model is the ability to determine the price correction from the main trend that helps the investor to gain more profit.

This decision making model was tested on the database that includes the prices and trade volume of the most popular Russian shares from the December 1996 till the October 1998. We made a comparison of our decision making model results with the results of the model based on the simple MACD–Histogram that also worked good at the period from the December 1996 till the October 1998. It was found that the results of the VBBS–based model at this period are twice better.

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A Stochastic Algorithm for Solving Convex Semi-Infinite Programming Problems

A.V. Fedosova and S.K. Zavriev
(Operation Research Department, Moscow State University)

A stochastic outer-approximation algorithm for solving a convex semi-infinite programming problem

$$SIP: \qquad f(x) \to \min_{x \in X^0}$$

$$g(x,y) \leq 0 \ \forall y \in Y^0$$

is considered; $X^0 \subset \mathbb{R}^k$, $Y^0 \subset \mathbb{R}^l$.

The method incorporates mechanisms for active search of relevant constraints and for dropping of irrelevant constraints. Numerical experiments have been made for problem of elastic-plastic torsion of hollow bars.

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Preemptive Scheduling in Real–Time–Systems by Multicommodity Network Flow Techniques

M.G. Fourougian
(Computing Centre of RAS)

The problem of scheduling n jobs with specific processing requirement, release time and due date in real–time–system consisting of m parallel processors is considered. The processors are asumed to be uniform in the sense that they merely differ in processing speed. Processors can work on only one job at a time and each job can be processed by at most one processor at a time. Interruptions and preemptions are allowed and corresponding expenditures are took into consideration. A restriction of number of interruptions and preemptions in the system at a time is given. Furthermore, a restrictions of the processors communications which can be time-variable are took into consideration. The feasibility problem consisting of determining a feasible schedule (if one exists) is solved. This problem is NP-complete. The algorithm of solving this problem was elaborated. This algorithm is based on reduction of initial problem to integer multiproduct network flow problem. Necessary and sufficient conditions of existance of a fiasible schedule are received.

Set Contraction Methods for Nonconvex Nonsmooth Global Optimization

Efim A. Galperin
(Departement de mathematiques, Universite du Quebec a Montreal)
C.P. 8888, Succ. Centre Ville, Montreal, Que., Canada H3C 3P8
email: galperin.efim@uqam.ca

Set contraction methods can be viewed as generalization of the Banach contraction principle (distance contraction in a complete metric space). Different set contraction methods will be presented with applications to control, dynamic games, multiobjective optimization and engineering problems. Fuzzification of set description and choice criteria allows us to generalize the approach for applications in fuzzy control and in problems with fuzzy data.

Estimation of Initial Gas Reserves and Transfers in Block Model of Gas Field

P.A. Geresh, G.M. Geresh, B.G. Sushkov,
M.G. Fourougian, G.K. Kamenev, D.R. Gonchar
(Russian Joint-Stock Company "Gasprom", Computing Centre of RAS)

The method of estimation of gas field parameters (gas reserves and transfer coefficients) was elaborated. The method is based on use of gas field block model elaborated by P.A. Geresh and on solving a material balance equations systems.

As a rule, in the case of a pressure difference in different parts of exploited field is small a matrix of coefficients at undeterminate parameters of this system is singular. Known methods of solving the material balance equations systems are characterized by instability of results in relation to small variation of initial data. Suggested method does not have this defect and enables to estimate gas reserves and transfer coefficients at initial stage of exploitation of field. The method is based on minimizing the deviation of average pressure in blocks and pressure calculated by means of the model (direct comparison of parameters measured). Different numerical methods of solving this problem were realized by system EXCEL and programming language C. Elaborated programs were used for calculation of parameters of some gas fields.

Comparison of Two Hedging Strategies for Stock Portfolio

D.J. Golembiovski and A.S. Dolmatov
(Operation Research Department, Moscow State University)

Viena Exchange of futures and options has begun derivative trading on index of Russian blue chips from the November, 1997. This gives the possibility of Russian stock portfolio hedging.

The study is devoted to modeling of two different hedging strategies. We considered hedging of real Russia stock portfolio. The modeling was made on base of close prices of futures and options for the period from January till June of this year. Russian stock market has dropped down at this period. The considered portfolio has lossed about 50 percents of the cost by this.

One strategy is a classical δ -γ hedging. The modeling has shown that this method can not hold such great fall. The loss of the portfolio at the end of June was about 20 percents of the start value.

The alternative strategy is the one horizont method. The lognormal distribution of the underline index values is used. The horizont is time period till the nearest expiration day. We consider the $\pm\sigma$ interval of the underline index value for this day. The portfolio is reconstructed every day such that we can get the profit for all index value inside this interval at the expiration day. The optimization problem is to maximize the portfolio cost expectation for this day. Modeling of such strategy shows attractive results. The profit of the portfolio for this period is about 40 percents.

The Concept of System Potential

V.A. Gorelik
(Computing Center of RAS)

The questions of potential definition and different problems of its maximization are considered.

On Interval Forecasting and Its Applications to Problems of Decision Making

L.G. Gurin
(Computing Center of RAS, Moscow)
E-mail: mohon@ccas.ru

In the report we consider an approach to construction of an interval forecast for a general type process with a discrete time. Dynamics of the process depends on controlling, stochastic, and indefinite factors.

There are two types of forecasts: dot and interval. In a phase space of the forecasted process the dot forecast is represented as one trajectory, while the interval forecast is a set of trajectories the number of which is not less than two. Usually this set is infinite. In the report

some techniques for construction of an interval forecast are offered. The techniqes were specially developed to produce forecasts greatly suitable for further computer processing. That was achieved by description of an interval forecast trajectory set as a system of equations and unequalities, that is in a form convenient for its perception with a help of a computer. The techniques assume a combined use of stochastic forecasting methods, expert estimation and one of the artificial intelligence models: semantic networks.

Essential Covering Method for Visualization of Criterion Tradeoff in Non-Linear Multiple Criteria Decision Problems

G.K. Kamenev
(Computing Center of RAS)

The Essential Covering Method (ECM) for non-linear multiple criteria decision problems is considered. The ECM is the further development of methods for stochastic simulation of non-linear systems. It is aimed at the visualization of criterion tradeoff curves. The ECM allows to approximate the entire feasible set in criterion space and to visualize its efficient border.

The research is supported by grant N. 98-01-00323 of RFBR.

Hyperbolic Transformations in Solution of LP Problem with Empty Set

V.A. Kondratyeva
(Moscow Pedagogical State University)

LP problem without solution is considered. Questions of minimum matrix variation are investigated and method of pseudosolution is developed.

Analysis of Solutions of Multiprocessor Scheduling Problem

V.P. Kozyrev
(Computing Centre of RAS)

There are N jobs or tasks and finite number of processors (or machines). Every job is characterized by a directive interval and time of performing. It is necessary to find a minimal number K of processors for executing all jobs, if every job must be performed continously on one processor. Using the earleast and latest possible times of finishing jobs it was introduced three binary relations: 2-consistent, 1-consistent and 2-nonconsistent. It was proved that if all pairs of jobs are: 1) 2-consistent then K is not more than $N/2$; 2) 1-consistent then the graph of all 1-consistent pairs is a transitive tournament; 3) 2-nonconsistent then

$K = N$. As conclusions it was described three polynomial cases of exact solutions of finding K. It is cinsidered the permissible interconnections of complete subgraphs with edges of different relations. Also it was described two polynomial algorithms of finding low and upper bounds of K. It is known that the general problem of finding K is NP-complete.

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Formalized and Unformalized Knowledge in Solving Classification Problems for the Ill Formalized Subject Domaines

M.G. Kreines
(Moscow Medical Academy, Moscow Center for New Information Technology in Medical Education)
E-mail: Nnovik@ccas.ru

To improve theoretical understanding the ways how the human beings use formalized and unformalized knowledge we develope and study in details mathematical models aimed to description and analysing the humanian behavior in solving classification problems as purposeful behavior. Applying the formal model, we come to general conditions for feasibility and efficiency of a usage of inexact knowledge and unformal interpretation of the results of solving classification problems on the base of formalized knowledge. We obtain the sufficient conditions of unfeasibility of an unformal interpretation and develope methods for estimating the formalized knowledge efficiency for solving professional classification problems in ill formalized subject domaines.

On the base of our theoretical models we develope methodology of constructing a formal professional knowledge representation language when the both formal and unformal knowledge are important for reasonable solving classification problems. The developed structures of the formal representation of knowledge are used as the base for new information technology of knowledge processing.

Intellectual Technology of Semantic Information Search: KEY TO TEXTS

M.G. Kreines, A.A. Afonin, A.E. Bolshakov, and V.A. Purtov
(Moscow Medical Academy, Moscow Center for New Information Technology in Medical Education)

Available volumes of computer and telecommunication archives, libraries, and databases make impossible personal acquaintance with their contents for a user. This is the main reason to develop information technologies for semantic search in electronic archives and data mining. But the standard ways of information retrieval are not efficient. This is

a usual thing that a user gets a lot of uninteresting texts or nothing at all as a result of the standard information retrieval process.

Principally new matter in information retrieval with KEY TO TEXTS is no need for a user to generate by him/herself the set of key words as a search pattern. The point is that computer technology KEY TO TEXTS is based on the original computational identification of the set of key words for a text: actually its semantic pattern.

We have created an original and efficient intellectual computing technology of information search, KEY TO TEXTS, based on the text semantic analysis. Applying our methods allows user to search for texts that are semantically similar to given samples or to the search pattern. The methods are applicable to any subject area.

By now Intellectual technology of information search KEY TO TEXTS have been proved to perform well and reliably with the following problems: searching for texts with content similar to a given sample, automated (computer) classification of texts, automated reviewing. The system is able to analyze texts in both Russian and English.

The range of application of KEY TO TEXTS may span over analyzing information stream from news agencies or news papers as well as searching for relevant scientific publications. It's important that in the latter case a user needs only to specify examples of the scientific results he/she wants to search.

The typical features of technology KEY TO TEXTS are high quality and reliability of automatically semantic search for the information in computer and telecommunication archives, libraries, and databases. For the information retrieval technology, the ability of KEY TO TEXTS to find content-similar texts in different kinds of sources is of grate value.

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Fixed Point Theorems for Decreasing Mappings

N.S. KUKUSHKIN
(Computing Center of RAS, Moscow)

This research has been motivated by the desire to understand under what conditions decreasing best replies ensure the existence of a Nash equilibrium. The point is that while both kinds of monotonicity emerge quite often in economic models, for increasing best replies there is such a powerful tool as Tarski's (1955) fixed-point theorem, whereas for decreasing best replies there is no comparable general result.

From the game-theoretical viewpoint, each theorem specifies conditions under which for any choice of decreasing single-valued selections from the best reply correspondences there exists a Nash equilibrium where each player uses this pre-specified selection; no assumption like upper hemi-continuity on the best reply correspondences is needed. This feature ensures a wider area of possible applications. In particular, our reactions need not be Nash best replies: when the existence of the best replies is

not guaranteed, we may hope to find ε-optimal decreasing reactions and obtain the existence of an ε-equilibrium.

The first result presupposes restrictions on dependencies between the players, i.e., on "who may influence whom"; such restrictions can be represented by an oriented graph, the absence of an arc from i to j meaning that j cannot react to the choice made by i. **Theorem 1** states that such a system of restrictions ensures, by itself, the existence of a fixed point for any collection of decreasing reactions if and only if the corresponding graph has no cycle with an odd number of arcs.

Then we add a restriction on the functional form of the reaction functions: each player is supposed to react only to the maximum of scalar characteristics of the relevant partners' choices. **Theorem 2** shows that the mutuality condition – if i may influence j, then j may influence i – is sufficient for the existence of a fixed point under the restrictions.

In the next result, the reactions are decreasing w.r.t. additive orderings; more precisely, each player reacts to the sum of scalar characteristics of all the partners' strategies (restrictions on dependencies are not allowed here). **Theorem 3** establishes the existence of a fixed point under these assumptions.

On Influence of Reliability of Human Information on the Results of Decision Making Methods Application

Oleg I. Larichev and Artyom A. Asanov
(Institute for Systems Analysis, RAS),
9, pr. 60-let Octyabrya, 117312, Moscow, Russia

A central problem examined in the paper is the problem of human mistakes influence on the output of decision making methods and systems. A new approach is proposed for the analysis of this problem: the same task is accomplished by a group of subjects using two different methods with the identical methodological basis; then the results are co mpared. The approach is applied for two methods of verbal decision analysis ZAPROS and ORCLASS. The obtained results reveal good consistency of criteria importance estimates. Also we discuss the problem of correlation of human measurements accuracy and decision making support systems output accuracy.

Effective Algorithm for Solving One of Two NP-Complete Tasks

Vasilij N. Lebedev
(Volgograd State University)

We prove NP-completeness the ergodic partition and the ergodic partition on the regular graphs. We give polynomial probabilistic algorithm for solving one of two that problems.

An application for the cyclical games in dynamics conflicts is considered.

On Solution-Containing Ellipsoids in LP

IGOR S. LITVINCHEV
(Computing Center RAS, Moscow)

Ellipsoids that contain all optimal dual slack solutions, those that contain all optimal primal solutions and primal-dual containing ellipsoids are derived for the linear programming problems. These ellipsoids are independent on the algorithm used to solve the problem, but depend on the initial localization of the optimal solution set. To derive such a localization, some constraints of the primal and (or) dual problem are used. In particular, the primal-dual containing ellipsoid has the form

$$\| \overline{X}(z - z_0) \|^2 + \| \overline{Z}(x - x_0) \|^2 \leq \varepsilon^2,$$

where

$$\varepsilon^2 = (\overline{x}^t, \overline{z})^2 - \| \overline{X} z_0 \|^2 - \| \overline{Z} x_0 \|^2,$$

$$\{x_0, z_0\} = \arg\min\{\| \overline{X} z \|^2 + \| \overline{Z} x \|^2 | \ (x, z) \in W\}.$$

Here $\overline{x}$ and $\overline{z}$ are strictly positive primal and dual-slack feasible solutions for the LP-problem in the standard form, while W is a convex set containing all primal-dual optimal solutions. Some applications of the containing ellipsoids in aggregation and interior point techniques are discussed.

Vitality and Vulnerability of Power Energy Networks

YURI E. MALASHENKO
(Computing Center RAS, Moscow)

The paper is devoted to studying vitality of power networks. The author major purpose is to encourage power specialists to foreknow consequences of various possible disturbances in power network structure. Thus we develop a methodology of computer simulation for power greed defeates followed by reconstruction including power flow redistribution. The main idea is to use network model with multigraph whose layers correspond to different types of energy resorses and several time periods [1]. Different types of resourses can be converted into each other at the graph nodes which link corresponding layers. Also, all the time steps are connected through the special accumulation nodes. In this way, the system of power energy production and transportation to consumers is represented by a singlecommodity network whose vulnerability may be studied according to [2].

For optimal flow distribution, the shortest path algorithm of subgradient type [3] is recommended. The arc length is defined with the aid of penalty functions. The arc capacities may be down as a result of a disturbance that may be specified by the user.

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On Decomposition of the Linear Programming Problem with Binding Constraints and Variables

YU.V. MEDNITSKI
(Computing Center RAS, Moscow)

In a work the block linear programming problem with binding constraints and variables is considered:

$$\sum_{k=1}^{K} c^k x_k + c^0 x_0 \to \min,$$
$$\sum_{k=1}^{K} A_k x_k \geq b_0,$$
$$B_k x_k + D_k x_0 \geq b_k, \quad x_k \geq 0, \quad k = 1, \ldots, K.$$

To such problems (without the introduction of essential extra assumptions about structure of submatrices A_k, B_k and D_k) is badly applicable both direct and dual methods of decomposition. As well applying of complicated decomposition scheme based on the Dantzig-Wolfe's decomposition method does a little effect. That is why for problems with such structure of constraints is suggested decomposition scheme based on the carried out at same time two iterative processes in the spaces of variables of direct and dual problems. Particular example of generalized production-transport problem is considered.

Some Discrete Programming Problems with Two and Three Criteria

I.I. MELAMED, I.KH. SIGAL
(CC RAS Moscow)

The computational study bi- and threecriteria assignment (AP), spanning tree (STP), traveling salesman (TSP) and knapsack (KP) problems are provided. Cardinality $|P(Y)|$ Pareto optimal solutions and part α of $|P(Y)|$ which can be found from the solution of set

linear parametrized unicriterion problems for the MINSUM - MINMAX, MINMAX - MINMAX, MINSUM - MINMAX - MINMAX, MINMAX - MINMAX - MINMAX problems are investigated. For bicriterial problems $|P(Y)| = O(\ln |M|)$, where $|M|$ is cardinality of the set of feasible solutions of the problem and for non-symmetric AP $|P(Y)|$ for STP and equal $2|P(Y)|$ for symmetric AP, $1.3|P(Y)|$ for non-symmetric TSP and $2|P(Y)|$ for KP with one constrain. For three criteria AP and STP $|P(Y)| = O(\ln^2 |M|)$, and values $|P(Y)|$ are equal. Linear parametrization of the criteria in discrete multicriteria problems only finds such Pareto optimal solutions which are also Pareto optimal for the continuous problem which is the convex hull of the set of solutions of the discrete problem. The number of Pareto optimal solutions found by linear parametrization of the criteria in classic bicriteria and threecriteria discrete programming problems decreases monotonously with dimensions of the problem, but for threecriteria problems α is bigger then for bicriteria problems for same dimensions.

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Utility Functions for Continuous Preferences and Verbal Methods of Their Construction

V.N. Mikhno, A.N. Katulev, and N.A. Severtsev
(Tver State University)

Practical usage of utility theory models in decision making problems is restrained by discrepancy of the axiomatic designs of multiplicative utility functions (UF) offered to the present time to propeties of real preferences of the persons making decisions (PMD), and by difficulties of obtaining the information necessary for the construction of the UF. In the report the researching results ensuring the sanction of the specified circumstances for the problems with the continuous preferences of the PMD are represented. Their sanction is provided by:

1). Substantiation of a class of models representing the multiplicative UF, containing representation for continuous preferences of the PMD of any structure. The elements of a class of the UF designs are caused only by assumptions of the continuity of the preferences of the PMD, of the equality of the expected limiting standards of substitution between criteria as a condition of the strategic equivalency of functions and do not use assumptions about the utility independence and/or preferance of the criteria.

2). The algorithms of the quaranteed revealing of the necessary quantitive information for the construction of the UF on the basis of the quality judgements of the PMD and authentic estimation of its errors.

3). The methods of the structural and parametrical identification of the UF in a class of the offered designs on the basis of search of the structure of the UF with the minimal complexity at the coordination of the accuracy of its definition with an error of the used information.

It is shown analytically and experimentally that the developed methods of the construction of the UF meet requirements of the serial (verbal) analysis of the decisions laid down by O.I. Larichev (1995). Program realization of the given methods in a number of applied systems of support of acceptance of the decisions and their application in practice illustrate their adequacy to a wider class of tasks in comparison with known.

To the Theory of Fundamental Polyhedrons

A.A. Mironov and V.I. Tsurkov
(Computing Center of RAS)

We introduce the notation of so-called extremal pairs of vectors. For transportation problems with these pairs, there is unique fissible matrix solution of zeros and ones. Consider convex hulls of extremal pairs of vectors. The application of the theorem of extremal points from functional analysis shows that the extremal pairs determine the vertexes of the hull, and any pair of vectors multiplied by some coefficient belongs to this hull.

Reception of Information in Nonantagonistic Games

E.Z. Mokhonko
(Computing Center of RAS, Moscow)
E-mail: mohon@ccas.ru

At present the social-economical and biological control systems subject to the huge information influence which they incapable to ignore. The destructive force of the non-optimum information influence is not investigated. The ways of protection from the non-optimum information influence are not elaborated. It is necessary to create information ecology.

Some peculiarities of the optimum information regimes of the reception of information can be investigated in the framework of the game theory. The report is a review of the author's results on investigation and optimization information processes in nonantagonistic dynamic games, namely, differential games and repeated games with continuous time.

The scheme and mathematical apparatus are elaborated for the solution of the problems of the dynamics of information reception in nonantagonistic conflicts. The peculiarities of the systems of the information reception of players take into account.

New statements of the problems are introduced which have not been considered earlier in the game theory. The problems are solved for the wide class of cases. By this an application field of game theory is enlarged.

New types of strategies, namely r-strategies, rs-strategies, Mr-strategies are introduced. They permit to model new possibilities and restrictions in the information receipt of the players and thereby they give a new possibility to describe the nonantagonistic conflict more adequately to the reality.

Game Theory Methods of Estimating Functionals of Stochastic Processes

M.P. Moklyachuk
(Kyiv university, Ukraine)

With the help of the classical Wiener-Kolmogorov method of extrapolation, interpolation and filtering of stationary stochastic processes the spectral characteristic $h(f,g)$ and the mean square error $\Delta(f,g)$ of the optimal linear estimate of the transformation $A\xi$ of the unknown values of a stationary stochastic process $\xi(k)$ from observations of the process $\xi(k)+\eta(k)$ can be found in the case where the spectral densities $f(\lambda)$ and $g(\lambda)$ of the processes $\xi(k)$ and $\eta(k)$ are known.

In practice, however, the problem of estimation arises where the spectral densities are not known exactly. The usual approach to solve the problem is to find the parametric or nonparametric estimates of the unknown spectral densities and apply the classical method provided that the estimates of the densities are the true one. This procedure can result in a significant increasing of the value of the error as Vastola and Poor [1] (see [2] for more details) have demonstrated with the help of some examples. For this reason it is necessary to search the estimate that has the least value of the error for all densities from a certain class of possible spectral densities. The spectral characteristic of such an estimate is called minimax-robust.

We apply the game theory methods (see [3]) and convex optimization methods (see [4]) to determine the least favorable spectral densities and the minimax-robust spectral characteristics of the optimal estimates of transformation $A\xi$.

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Optimal Choice in Dynamic Controllable Systems

U.M. Mukhtarov
(Math. & Mech. Institute, Baku)

In this abstract, the problem of existence of equillibrium situation in the differential games with dependent constraints (d.c.) is considered. Consider nonantagonistic two-person differential game with folloing relations:

$$\dot{x} = f(x, u, v, t), \quad t \in [0, T], \quad x(0) = x^0, \tag{1}$$

$$u \in U, \quad v \in V, \tag{2}$$

$$(u, v) \in P \subset U \times V, \quad P_u \subseteq U, \ P_v \subseteq V, \tag{3}$$

$$I_1(u, v) = g_1(x(T)), \quad I_2(u, v) = g_2(x(T)), \tag{4}$$

where x is n-dimension state vector, u and v are p- and q-dimension vector functions. The values u and v are chose by first and second player, maximaizing continuous payoff function g_1 and g_2, respectively.

Moreover, in order to overcome some dificulties when the problem is desided it is introduced an idea of so-called "responsibility" for fulfilment of dependent constraints (3):

1) Only the first player is responsible for fulfilment of d.c. (3).

2) Only the second player is responsible for fulfilment of d.c. (3).

3) The both players are responsible for fulfilment of d.c. (3).

For simplicity the payoffs of both players are modified by assignment $-\infty$ out of constraint set P.

Finally, in this game the maximal guaranteed gain of the first player is obtained.

The Problem of Vulnerability for Telecommunication Networks

I.A. Nazarova
(Computing Center of RAS, Moscow)

The paper is devoted to the problem of multicommodity network vulnerability. The problem is formalized as a lexicographic optimization problem. Branch-and-bound method is applied for its solving.

A telecommunication network is described by finite connected undirected graph with weight (capacity) prescribed to its edges. The set of pairs of nodes, called source and sink, is given. Each pair is characterized by a positive number: the flow demand from source to sink. Flows of different pairs cannot be replaced one by another. Two criteria are chosen for estimating the network quality: the level of demand satisfaction and the sum of unsatisfied flow demands.

Given natural W the set of edges is to be found such that:

1) removing them from network disconnects at list one source and correspondent sink; 2) the total capacity of these edges is not greater then W; 3) the sum of unsatisfied flow demands is maximal.

The applications of this model helps in advance to know the consequences of ceasing to function for some of the network elements (e.g. their fault, destruction, etc.).

The research is supported by grant N. 98-01-00233 of RFBR.

On Influence of Goods Substitution Elasticity on Market Processes Stability

Natalia K. Obrossova
(Moscow State University)

There exists the hypothesis that the features of manufacture technological structure appear to be an obstacle for the formation of civilized market relations in Russia. These features are connected with the historically formed in the USSR strong specialization of manufactures, and thus low goods substitution elasticity. That report suggests the approach explaining why low elasticity of substitution may prevent from forming market relations. The approach is based on the hypothesis that rise of economic crisis is caused by the equilibrium prices stability loss, and the beginning of complicated dynamics in price formation models that is the obstacle for the rational behavior of economic agents (see [1]).

Let us consider the price formation model of Walras type with producers delay on the market of two partially substitutable goods. It's shown that there exists such a value depending on the commodity necessity [1], that the market processes stability boundary doesn't depend on the elasticity of substitution σ when $\sigma \geq \hat{\sigma}$ while when $\sigma < \hat{\sigma}$ stability domain reduces with σ reducing and stability boundary aims to the constant value when $\sigma \to 0$.

This investigation is supported by RFFR N 96-01-00664.

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A Parallel Continuation Algorithm for Global Optimization

I.V. Orlyanskaya, Y.N. Perunova, and S.K. Zavriev
(Operation Research Department, Moscow State University)

The global minimization of a smooth function $F(\cdot)$ on a k-dimensional box is considered. Under some nonsingularity assumptions the optimization problem has a special parametric structure and its global solutions lie on a finite family of locally-quasioptimal trajectories. A continuation method for global optimization is proposed. The essence of the method is as follows: i) find all local minima of $F(\cdot)$ on an edge; ii) step by step with $n = 1, 2, \ldots, k-2$ using a path-following technique continue all local minima of $F(\cdot)$ on n-dimensional facet to obtain all local minima of $F(\cdot)$ on $(n+1)$-dimensional facet; iii) continue all local minima of $F(\cdot)$ on $(k-1)$-dimensional facet to obtain the locally quasioptimal trajectories; iv) searching on the locally quasioptimal trajectories to obtain a global solution of a problem.

Proposed global minimization method is convenient for parallelization with a number of processors searching on different quasioptimal trajectories. This parallel algorithm have been implemented and tested on a parallel computer PARSYTEC at the Computing Center of Russian Academy of Science.

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Enumeration of K-Shortest Spanning Trees

MAXIM D. PAPORKOV and JOSEPH V. ROMANOVSKY
(University of St.-Petersburg)

Here we present an approach to enumerate elements of a set of spanning trees of a graph by ascending of the total weight of arcs of a tree.

The main our idea is to manipulate with *processes*, each solving the problem to enumerate a set of values associated with this process, and *to construct new processes from ones defined previously* with a rather modest set of operations.

Consider the following operations with an undirected graph.

1. *Partition for biconnected components.* The process of enumeration of spanning trees of the graph is the sum of similar processes for its biconnected components.

2. *Branching by an edge.* Let the graph be biconnected. Select an edge, split the set of all spanning trees to the set of trees including this edge and the remaining set of trees. The required process of enumeration all trees can be constructed by merging the processes enumerating trees in this two subsets. To obtain the maximum difference between minimum tree including selected edge and minimum tree without this edge, we implement a special selection procedure.

In case of directed tree the approach is similar.

About Nonnuclear Deterrent Mechanism

YU. N. PAVLOVSKY
(Computer Center of Russian Academy of Science)

The nuclear weapons call into being nuclear deterrent mechanisms. This mechanisms have result in essential decrease large scale armed conflict probability. Now this mechanisms are one of the reason nuclear disarmament refusal. The nuclear deterrent mechanisms is complicated phenomenon. In the report are discussed phsychological, ecological, information aspects of this phenomenon. Suggestion is made to use one of this aspect — the possibility to sufficiently exact prognosis of conflicts developing, victims amount, prognosis of economical, political, ecological consequences, to call into being nonnuclear deterrent mechanism. Foundation of this suggestion is the idea: in the morden world to prevent armed conflict for any state strategically is more profitable then to win the conflict.

On Decomposition Way to Creation of Numerical Methods in Global and Multicriterial Optimization

N.M. Popov
(Moscow)

The decomposition methods of global and multicriterion optimization are considered in the report. We propose, that we have two or more ways for computation of criterion values in optimization problem. We call such ways by computational models of criterion. We propose also, that computational models are coordinated, and they are distinguished in accuracy and complexity. The more exact computational model of criterion is more complex too; and, vice versa, more rude model is more simple.

These different computational models are combined in our decomposition methods, consisted of several stages. Suggested decomposition methods make possible to except non-optimal points on the initial stages with the help of rude simple models of criterion. So, the decomposition methods permit to economize computations of criterion values on the exact complex model during the all solution process of optimization problem.

The created methods are oriented on the optimization problems in projecting of technical objects. Some tests and real examples of applications of the decomposition methods are discussed in the report too.

On Realization of Classifying Algorithms with Successive Training

I.M. Promakhina
(Computing Center of Russian Academy of Sciences, Moscow)
E-mail: imp@ccas.ru

A class of classifying algorithms is considered in which training points are produced successively. Every training point causes a stochastic splitting of one of the stochastic areas built during preceding steps, that is the area it gets into. In previous works convergence of the algorithms was proved in a case of evenly distributed training points.

Realization of the algorithms is based on representing of the stochastic splitting in a form of an oriented tree. The end of any rib in the tree corresponds to a training point that splits the area which is a result of a preceding splitting caused by a training point corresponding to the beginning of the rib. Classifying of a given point is treated as a path along a branch of the tree. For any continuous distribution of a training sample it was proved that the length of the path is no greater than $O(ln^2 n)$, where n is an infinitely increasing number of training points. A method of stochastic permutations is developed for realizing the succussive training when a training sample is of a fixed volume.

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On Defining Optimal Composition of Machines and Equipment to Fulfil Set of Jobs

S.F. Rogov
(Moscow), ph 461 76 29

The defining optimal compositions of machines and equipment to fulfil set of jobs such as agriculture jobs is rather useful and instructive problem of operation research. This discrete model describes wide class real situaitions, connections between jobs, compositions of complete set of the aggregates. It is necessary to find

$$\min_X \sum_{i=1}^{n} C_i = X_i.$$

Here $C_i \geq 0$ is the cost of complect of the aggregate of i-th type, $X_i \geq 0$ is integer quantity complect of aggregate i-th type.

The constrains are conditions to do all works:

$\sum_{l \in I_k} x_{kl} \leq X_k$ (a balance of quantities of complects of aggregates),

$\min_{k \in J_1} a_{kl} x_{kl} \geq X_k$ where a_{kl} is standart of productivity of complects of aggregates for work k-th type.

It is useful and necessary to use sets of transformations with associative binary operation over the set of vectors with coordinates which are not negative integer to get the algorithms of defining global and local optimum. Both oracul algorithms and algorithms wich take into consideration the structure of permisible set are good to use. Using enclosing relations of partial order which are monotonouse for function of goal and semigroups of transformations leads to increase of necessary computer storage to solve the problem. As always these tranformations have interpretation of buying and selling sets of agregates wich do not increase the goal function.

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The Distribution Problem, the More for Less (Nothing) Paradox and Economies of Scale and Scope

Michael J Ryan
(Department of Economics, University of Hull)
Hull HU6 7RX ENGLAND, M.J.Ryan@econ.hull.ac.uk

In this paper I develop a goal programming approach to the representation and resolution of the more for less and more for nothing paradoxes in the distribution problem. In doing so I establish new ways

of deriving more for less and more for nothing results in relation variously to competitive and non-competitive market structures. Within these contexts I also introduce new and generally applicable definitions of economies of scale and scope and illustrate them by means of extended numerical examples.

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A Game-Theoretical model of Trade with Transportation

A.S. Semovskaya

(Moscow State University, OR Dept.)

Trade model that allows a transportation is described in terms of game theory. The following classes of independent players are introduced: producers, customers, and transport companies (dealers). Production costs and facilities are associated with producers, values and consumptions — with customers, costs of transportation and transport capacities — with transport companies. Transport companies declare both prices: purchase price for producers and selling price for customers.

Producers make decision what part of their product to sell for a given purchase price. Customers make decision what part of the product to buy for a given price.

Some special cases are analyzed. When there are two dealers with fixed purchase prices, Nash equilibrium for producer's game is found. When there is only one transport company or producers' (customers') coalition, the hierarchical game is solved.

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A New Technology Propagation Model. Attractor for the Lengmure's Chain

A.A. Shananin and Y.M. Tashlitskaya
(Moscow State University, OR Dept.)

This report examines modification of V.M. Polterovich and G.M. Khenkin's model of technological progress. It is assumed that the propagation of new technologies is the result of two processes: innovation and imitation of technologies of higher efficiency levels' enterprises. In contrast to Polterovich-Khenkin's model the imitation process has a "local" nature. Numerical computations show that this modification leads to the qualitative changes in asymptotic behavior of the solutions. To find the reasons for these changes the cause in which propagation of new technologies is due only to imitation process is analyzed. The change of variables leads to the system of ordinary differential equations, also known as the finite Lengmure's chain. Using the theory of moments' problem the attractor for the finite Lengmure's chain is revealed in analytical form and the explanation for results of numerical computations is suggested.

The research is supported by grants N.N. 96-01-00664 and 98-01-00777 of RFBR and grant "Scientific school" N. 96-15-96207.

An Approximation Method for Probability of Existing Maximal Flow on Random Two-Terminal Network

A.V. Shaparev and B.P. Filin
(OAO "Rostelecom", IPPI RAS)

A simple directed random graph is considered. A two-terminal network is defined on the graph. The arcs of the network have capacities and probabilities of failure. Concepts of maximal flow (MF), minimal support of MF (MSMF), and blocker for the MSMF clutter are used. Some method admitting to construct the MSMF clutter sufficiently quickly is suggested. A duality principle elaborated by one of the authors

is used. On every step some two-sided bounds for the probability of MF existing are calculated. Each of them tends to the probability monotonically.The method has admitted to solve the NP-hard problem under consideration for real large-scale data networks (for example, for digital network OAO "Rostelecom").

A Method of Constrained Stochastic Programming

DMITRY SOLOMAKHIN
(Moscow State University, OR Dept.)

This abstract deals with the stochastic method for solving the stochastic programming problem

$$\min\{\mathbf{E}f(x,y)|\ x\in\mathcal{X},\ y\in Y\}$$

where $\mathcal{X}=\{x\in X|\ g(x,y)\le 0$ a.s. for each $y\in Y\}$, a.s. = almost surely,
$\mathbf{E}$ is the averaging operator w.r.t. y.

The main idea of the algorithm presented in this paper is to replace the infinite number of constraints with the finite one on every iteration similar to [1]. At each step the constraints are picked up at random.

Let us suppose functions $f(\cdot,y):\ \mathbb{R}^n\to\mathbb{R}$ and $g(\cdot,y):\ \mathbb{R}^n\to\mathbb{R}$ to be convex for each $y\in Y$ and the set X be convex compact. According to these assumptions, the general scheme of the algorithm is formulated below.

Let us fix a sequence of numbers

$$\tau^k:\ \tau^k\ge 0,\ \tau^k\to 0,\ \Sigma\tau^k=\infty.$$

Let $\xi^1,\ \xi^2,\ldots$ be a sequence of random variables which are uniformly distributed over Y. Given the current iterate x^k, define x^{k+1} as a solution of the subproblem

$$\min\{\tau^k f(x,\xi^k)+|x-x^k|^2/2|\ x\in X\bigcap\mathcal{X}_k\}$$

where $\mathcal{X}_k=\{x\in X|\ g(x,\xi^k)\le 0\}$.

Under some regularity assumptions on the feasible set, the a.s.-convergence of the algorithm is proved.

The research is supported by grant N. 96-01-00786 of RFBR.

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A Game Model for Estimating Investment Projects

S. Solovyova
(Moscow State University, OR Dept.)

The director's counsil of a bank consisted of $N = \{1, \ldots, n\}$ members has to choose one of p offering projects. Every project a_i has two characteristics: the price $p_i = p(a_i)$ and the gain Δ_i which is the difference between the profit of this project and its price. Let set A of projects be ordered such that $a_i \prec a_{i+1}$, $a_i \neq a_{i+1}$, $i = 1, \ldots, p$, moreover $\Delta_i \leq \Delta_{i+1}$, $p_i \leq p_{i+1}$. If $f(a_i) \leq f(a_{i+1})$ and $p(a_i) > p(a_{i+1})$ then we do not consider such a project a_i. If $\frac{\Delta_{i+1}-\Delta_i}{p_{i+1}-p_i} < \alpha$ (α is known beforehand) we do not consider the project a_i either. Every j-th member of the counsil acts in correspondence with his/her utility function $u_j(p, \Delta)$ which is not decreasing w.r.t. gain and is not increasing w.r.t. price. The assumption is the following: if each member of the counsil behaves honestly then the utility function is unimodal w.r.t. project numbers. Really, if prices are less than a price $p_{i_*(j)}$ and the gain increases then the j-th director wants to invest more money in more profit projects. If prices of projects are higher than $p_{i^*(j)}$ then the j-th director can invest less money in more expensive projects although these projects are very profitable. But if prices are in the interval $\left(p_{i_*(j)}, p_{i^*(j)}\right)$ then this is the same for him which project to choose exactly.

Under these assumptions the voiting rule with ordering [1] is of good use. In the case, for each director it turns out to be better to show his truthful preference because this strategy is his dominant strategy and the equilibrium in dominant strategies is Pareto optimum.

The research is supported by grant "Scientific school" N. 96-15-96143.

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A Model of Duopoly with Variable Prices

S.V. Somov
(Moscow State University, OR Dept.)

We consider a two-stage finite horizon model of duopoly. By contrast with Marc Dudey's paper, price-setting and capacity-constrained duopolists have different reserve prices. Moreover, at the first stage of the model, they may reduce their capacity to avoid repeated Bertrand competition. At the second stage, the duopolists meet consumers with unit demands and common reservation value. The consumers come to market at different times, and the duopolists may change their prices at any time. The firms seek to maximize undiscounted profits.

The model has a subgame perfect equilibrium in pure strategies and unique equilibrium payoffs for any specification of the duopolists' capacities and reserve prices. The result of this work shows, that the

opportunity to reduce the supply makes both firms get rid of their surplus good. After the first stage of the model, the supply is equal to the demand. Then, at the second stage both firms sell out at the monopoly price.

The research is supported by grant N. 96-01-00999 of RFBR.

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Regulation of Economic Behavior

ALEXANDER VASIN
(Moscow State University, OR Dept.)

We examine three types of economic interactions and show that a proper centralized regulation is necessary to form the effective collective behavior in these interactions.

First we discuss a model of price competition in the market with a homogeneous good. The market seems to meet the conditions of perfect competition. However, we show that without regulation prices may essentially deviate from the Walrasian equilibrium and describe a simple regulation mechanism which ensures stability of this equilibrium.

The next model examines tax collection with corruptable tax inspectors. We determine the optimal probabilities of audit and reviewing by the tax authority and then study the comparative statics of net revenue with respect to the tax rate and fines for poor audit.

We show that increasing of tax rate or the fine may reduce the net tax revenue if the auditing strategy is not adjusted to these changes.

Finally we consider behavior in repeated interactions in small groups and show that this behavior is unstable with respect to small perturbations of the payoff functions of participants. For any feasible and individually rational outcome, we determine small prizes or penalties which depend on behavior of individuals in the interaction and ensure stability of the desirable outcome.

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On Asymptotical Stability in Adaptive Imitation Behavior Dynamics

A.A. VASIN and P.S. BOBROV
(Moscow State University, OR Dept.)

Adaptive Imitation is a behavior dynamics that take into account the ability of individuals to change their strategies by learning and imitation.

Definition. Consider a two-population game with the sets of strategies $R = \{R_1, .., R_m\}$ and $S = \{S_1, .., S_n\}$, p_i and q_j denote densities of individuals that played strategy R_i and strategy

S_j respectively. Payoff functions $A_i(q), i = 1..m$, $B_j(p), j = 1..n$ characterize the result of interaction for all strategies.

Let r_i denote the review rate of individual that played strategy R_i. With this probability he compares the payoff of his current strategy R_i and payoff of some alternative strategy R_k. He always keeps strategy R_i if $A_i(q) \geq A_k(q)$, otherwise he changes R_i for R_k with probability $\gamma(A_i(q), A_k(q))$ which monotonically increases in the difference $A_k(q) - A_i(q)$. Let π_k denote a probability to choose R_k as an alternative strategy, r_i and π_k may depend on the current distribution p and payoffs $A(q) = (A_1(q), .., A_m(q))$. Then distribution p over strategies in population 1 meets the following system: $\dot{p}_i =$

$$\sum_{k:A_k(q)<A_i(q)} p_k r_k \pi_i \gamma(A_k(q), A_i(q)) - p_i r_i \sum_{k:A_k(q)>A_i(q)} \pi_k \gamma(A_i(q), A_k(q))$$

Equations for q are similar.

Let Δ_1 and Δ_2 denote unit simplexes formed by $(p_1, .., p_m)$ and $(q_1, .., q_n)$ respectively. Let $\Delta = \Delta_1 \times \Delta_2$

Consider three different special cases. In each of them the review rate r_i doesn't depends on distribution and payoffs.

1) $\pi_i = p_i$; 2) $\pi_i = const$ for each i; 3) $\pi_i = \frac{1-p_i}{m-1}$

Proposition. Every point $\delta \in int\Delta$ is:

Case 1) never asymptotically stable;

Case 2) asymptotically stable if it is a rest point of this system;

Case 3) never asymptotically stable.

The technique of proof of this proposition first appeared in the work *Ritzberger, Vogelsberger (1990) "The Nash Field"* and uses one certain reparametrization of time, calculation of field divergence and Liouville's theorem.

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and grant "Scientific school" N. 96-15-96143.

Option Value of Capital Project Portfolio under Uncertainty

ALEXANDER A. VASIN and VLADIMIR V. MOROZOV
(Moscow State University, OR Dept.)
Alexander A. Vasin, Professor, vasin@cs.msu.su,
Vladimir V. Morozov, Associate Professor, operat@cs.msu.su.

Consider a firm which compares m investment opportunities. Every possible capital project j requires a fixed sunk cost I_j at the start of its realization and then brings a profit $P_j(t)$. The functions P_j meet equations $dP_j = \alpha_j P_j dt + \sigma_j P_j dz_j$ where z_j are standard Wiener processes. The firm can invest to the project j immediately and get the NPV $V_j(P_j) = P_j/(\rho - \alpha_j)$. But it can delay an investment and wait

for the greater value of the profit. The problem is to evaluate the portfolio option and to find an optimal investment decision rule. We show that it can be formulated as a free boundary problem for an elliptic equation. Dixit and Pindyck [1] solve the problem for a single investment project j. They have found an optimal threshold decision rule and a corresponding option value $F_j(P_j)$: to wait if $P_j < P_j^*$ and to invest if $P_j \geq P_j^*$. Thus, $F_j(P_j) = A_j P_j^{\beta_j}$ in the first case and $F_j(P_j) = V_j(P_j) - I_j$ in the second one.

We present a solution of the problem in the following cases:

a) The firm can realize all projects. The portfolio option value is the sum of single project option values. The firm invests to each project independently using the corresponding optimal investment rule.

b) Zero volatilities σ_j, incompatible projects. The firm chooses a project with the largest $F_j(P_j)$. This maximum is the option value of the portfolio.

c) Small volatilities, incompatible projects. The first order approximation of the portfolio's value is the maximum of single project's values. The decision is to realize $j^*(t) \in Arg\max_j F_j(P_j(t))$ as soon as $P_{j^*(t)} \geq P^*_{j^*(t)}$.

This work was supported by Society of Actuaries, research project *Mathematical Models and Software for Financial Organizations At Risky Markets* and by Russian Fund of Basic Researches, grant N 97-01-00245.

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Limit Saturated Edges for Supercompetitive Concurrent Flow in Networks

NATALYA YEZHKOVA
(Moscow State University, OR Dept.)

Given a multicommodity network $\mathbf{S} = \langle V, P, R \rangle$, where $V = \{v_1, \ldots, v_n\}$ is a vertex set of the network physical graph, $R = \{\mathbf{r}_1, \ldots, \mathbf{r}_e\}$ is an edge set of the network physical graph, and $P = \{\mathbf{p}_1, \ldots, \mathbf{p}_m\}$ is a set of source-sink pairs (SS-pairs) — pairs of physical vertices which should be connect. Let $d_i > 0$ be the demand for flow between source v_{s_i} and sink v_{t_i} for every SS-pair $\mathbf{p}_i \in P$. Let $c_k \geq 0$ be capacity of edge $\mathbf{r}_k \in R$. We impose capacity constraints on each edge and conservation equations on flow for each vertex. As usual it's impossible to satisfy the demands for all SS-pairs in the given network. Because of we should find any valid concurrent flow, for example supercompetitive concurrent flow. Vector of commodity flow values $z = (z_1, \ldots, z_m)$ corresponds to this concurrent flow. Throughput of the SS-pair $\mathbf{p}_i$ is equal $\dfrac{z_i}{d_i}$.

SS-pair throughputs are depend on edge capacities, but if we reduse capacity of any edge then throughputs may not be decrease. So the concept of δ-limit and limit saturated edges appears. There are edges which capacity reduction by $\delta > 0$ in first case or by *every* $\delta > 0$ in second leads to throughput decrease for any SS-pair. Such edges are interesting for problem of defense or of increase network capacity. An algorithm for δ-saturated and saturated edges finding is given in its definition. As an example we can take a model for the network of Moscow metro.

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Graphical Image of the Economical Model in the System of Support of Mathematical Modeling of Economy, ECOMOD

N.K. Zavriev
(Computing Center of Russian Academy of Sciencies, Moscow)

ECOMOD system tool for support of mathematical modeling of economy is presented. The purposes of ECOMOD have been proclaimed on the Conference in Geneva in 1996. Briefly the ECOMOD system should support the proper structure of an agent-based macroeconomic model taking into consideration the natural ambiguity of economic concepts. It also should implement computer experiments, save results and help to compare related models.

The system is based on the classification of model relationships and variables which expresses their meaning. The main items of classification are "agent" and "interaction". Agent is a group of relationships which describe a certain choice problem and has prescribed structure of choice problem. Interaction is a group of relationships which describes how agents' expectations are put into agreement by information exchange. (Information is usually presented by special "flexible" model variables such as prices). Interaction groups often may be formed on the base of known examples (competitive market, monopolistic market, etc.). The main items of classification of variables are "assets" and "signals". Stocks and flows of assets describe material and financial possibilities of agents while signals describes agents' environment.

ECOMOD checks relationships' syntax, balances of assets and correctness of information exchange description. Alternative graphical level of the representation of the knowledge about the models of economy is realized by a presented formalism. Visualiser creates a graph-like structure which shows the model's components (agents and their roles in interactions, interactions, stocks, streams etc.). This kind of view simplifies the comprehension of the model's functioning and exposes some differences and similarities of the models, which helps to divide them into classes of related ones.

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[1] Abstracts are alphabetically disposed by the last name of the first of authors

V.N. Lebedev	GT
I.S. Litvinchev	LP
Yu.E. Malashenko	N
Yu.V. Mednitski	LP
I.I. Melamed, I.Kh. Sigal	MDM
V.N. Mikhno, A.N. Katulev, N.A. Severtsev	MDM
A.A. Mironov, V.I. Tsurkov	DO
E.Z. Mokhonko	GT
M.P. Moklyachuk	GA
U.M. Mukhtarov	GT
I.A. Nazarova	N
N.K. Obrossova	ESMB
I.V. Orlyanskaya, Y.N. Perunova, S.K. Zavriev	OM
M.D. Paporkov, J.V. Romanovsky	DO
Yu. N. Pavlovsky	Plenary
N.M. Popov	MDM
I.M. Promakhina	MT
S.F. Rogov	DO
M.J. Ryan	MT
A.S. Semovskaya	GA
A.V. Shaparev, B.P. Filin	N
A.A. Shananin, Y.M. Tashlitskaya	ESMB
D.D. Solomakhin	OM
S. Solovyova	GA
S.V. Somov	ESMB
A.A. Vasin	Plenary
A.A. Vasin, P.S. Bobrov	ESMB
A.A. Vasin, V.V. Morozov	F
N.V. Yezhkova	N
N.K. Zavriev	ESMB

SECTIONS	Conference hall	**Date, time**
Opening Session	Vavilova, **40**	17.11.98, 12-00
Plenary	Vavilova, **40**	17.11.98, 14-30

Chair: P.S. Krasnoschekov

Speakers:

A.A. Vasin, Yu.N. Pavlovsky, M.G. Kreines, I.G. Pospelov

ESMB Vavilova, **40** 18.11.98, 10-00

Chairs: A.A. Petrov, A.A. Shananin

Speakers:

E.V. Avtukhovich, N.K. Obrossova, Y.M. Tashlitskaya, N.K. Zavriev 10^{00}–12^{00}

A.S. Bratus (A.B. Mescherin), S.V. Somov, A.S. Boyko, P.S. Bobrov, V. Podobedov 12^{30}–14^{30}

GT Vavilova, **40** 18.11.98, 15-00

Chair: V.V. Morozov

Speakers:

N.S. Kukushkin, V.N. Lebedev, E.Z. Mokhonko, U.M. Mukhtarov 15^{00}–17^{00}

GA Vavilova, **40** 18.11.98, 17-00

Chair: E.Z. Mokhonko

Speakers:

M.P.Moklyachuk, A.S.Semovskaya, S.Solovyova 17^{00}–18^{30}

MT Vavilova, **42** 18.11.98, 10-00

Chair: Yu.A. Flerov

Speakers:

L.G. Gurin, V.M. Bocharov, I.M. Promakhina, M.J. Ryan 10^{00}–12^{00}

N Vavilova, **42** 18.11.98, 12-30

Chair: Yu.E. Malashenko

Speakers:

B.P. Filin, V.P. Kozyrev, Yu. Brodsky,
A.E. Barabanov, 12^{30}–14^{30}

M.G. Fourougian, Yu.E. Malashenko, I.A. Nazarova,
N.V. Yezhkova 15^{00}–17^{30}

SECTIONS	Conference hall	**Date, time**
MDM	Vavilova, **40**	19.11.98, 10-00
Chairs: O.I. Larichev, A.V. Lotov		
Speakers:		
G.K. Kamenev, L.V. Bourmistrova, V.A. Gorelik, A.A. Asanov,		10^{00}–12^{00}
V.N. Mikhno N.M. Popov, I.I. Melamed (I.Kh. Sigal)		12^{30}–14^{00}
F	Vavilova, **40**	19.11.98, 14-30
Chairs: I.S. Menshikov, A.A. Vasin		
Speakers:		
A.A. Dirotchka, O.V. Petrova, S.V. Somov,		14^{30}–16^{00}
N. Evtikhiev, D.J. Golembiovski, V.V. Morozov		16^{00}–17^{30}
LP	Vavilova, **42**	19.11.98, 10-00
Chair: Yu.G. Evtushenko		
Speakers:		
I.N. Fokin, V.A. Kondratyeva, I.S. Litvinchev, Yu.V. Mednitski		10^{00}–12^{00}
DO	Vavilova, **42**	19.11.98, 12-30
Chair: V.I. Tsurkov		
Speakers:		
A.A. Mironov (V.I. Tsurkov), M.D. Paporkov (J.V. Romanovsky), S.F. Rogov		12^{30}–14^{00}
OM	Vavilova, **42**	19.11.98, 14-30
Chairs: N.M. Novikova, S.K. Zavriev		
Speakers:		
A.P. Cherenkov, D.V. Denisov, I.V. Orlyanskaya,		14^{30}–16^{00}
A.V. Fedosova, D.D. Solomakhin, N.M. Novikova		16^{00}–17^{30}