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Congratulations to Naum Shor on his 65th birthday

Jan 1, 2002 is the 65th birthday of Professor, Academician Naum Z. Shor. We know him for his outstanding contributions to nonlinear and stochastic programming, numerical techniques for nonsmooth optimization, discrete optimization problems, matrix optimization, dual quadratic bounds in multiextremal programming problems.

All his professional life is tied to the V.M. Glushkov Institute of Cybernetics in Kiev, Ukraine. He started to work there in 1958 after graduating from Kiev National Taras Shevchenko University by the invitation of Professor V.M. Glushkov, the supervisor of his diploma in differential algebra. He never changed his place of work. In this Institute he made his career from an engineer (1959) to the head of scientific department of methods for solving complex optimization problems (1983, till date).

Among the early works of N.Z. Shor is the modeling and optimization of the reliability of computing devices. Another important work involved determining the noise spectrum in radiolocation problems. These two works were accomplished under the supervision of Prof. V.S. Mikhalevich.

In 1960 on the basis of the group led by Mikhalevich the department for solving applied problems (mainly the problems of optimal planning and design) was established. Shor and Mikhalevich suggested an algorithmic scheme of the method of sequential analysis of variants. It was a generalization of dynamic programming algorithms. The scheme was much cited and used for optimal design of roads, electrical networks, central gas supply system and so on.

In 1961 Shor proposed so called principle of monotone recursion, being a basis of algorithms for optimal design of lengthy objects and objects with tree-like structure [later these results were published in the book (Mikhalevich and Shor, 1967)].

In 1962, Shor published the algorithm for solving a large-scale dual network transportation problem by reducing it to the maximization of a piece-wise linear concave function. In fact it was the first work where a subgradient method was used for optimization of nonsmooth functions (Shor, 1962). Similar methods combined with decomposition schemes were used to solve distribution planning problems in ferrous metallurgy, civil aviation etc.

In 1964 he received his Candidate of Physical and Mathematical Sciences degree (equivalent to Doctor of Philosophy).

Ermoliev and Shor (1968) have suggested a stochastic analogue of the subgradient processes for solving two-stage stochastic programming problems. This approach has been developed further by Ermoliev and his group. This approach was named direct quasi-gradient methods for solving optimization problems under uncertainty.

Professor Shor is well known not only for the method of generalized gradient decent which he proposed in 1962, but also for the family of methods which involve space transformation. This family contains two groups of methods:

(a) with space dilation in the direction of the subgradient (Shor, 1970);

(b) with space dilation in the direction of the difference of two successive subgradients (so called *r*-algorithm) (Shor, 1971).

Group (a) has been used for solving systems of nonlinear equations and inequalities. Group (b) has become one of the most efficient practical methods for solving the complex optimization problems.

The detailed description of subgradient and subgradient-type methods with transformation of the space of the variables developed by him was published in Shor (1979). This book was translated from Russian to English by K.C. Kiwiel and A. Ruszcynski in 1985.

In Shor (1979) and Mikhalevich et al. (1986) the applications of subgradient-type methods in realization of decomposition schemes in large scale optimization problems of special structure were described.

The numerical methods proposed by Shor widely explore an idea of space transformation. It is interesting that well known ellipsoid method independently proposed by A.S. Nemirovsky and D.B. Yudin is a special case of Shor's subgradient-type methods with space dilation in the direction of the difference of two successive subgradients (see Shor, 1977). The ellipsoid method enabled Khachiyan to construct the first polynomial-time linear programming algorithm and made a revolution in the computational complexity theory by works of M. Grötschel, M. Lovász and A. Schrijver.

Due the connections of graph theory network planning and control, Shor got interested in graph theory and particularly in the graph coloring problems. Together with his PhD student G.A. Donets, he published the monograph titled *Algebraic Approach to Plane Graph Coloring* (Shor and Donets, 1982). The hypothesis on the number of solutions in plane graph coloring was formulated. Numerical experiments confirm the likelihood of this hypothesis.

To his wide sphere of interests belong discrete optimization problems, matrix optimization, detailed study of dual estimates, particularly in boolean and quadratic multiextremal problems (see, for example, Shor and Stetsenko, 1989; Shor, 1992; Shor and Berezovski, 1992; Shor, 1995; Shor and Voitishin, 1996).

His book *Nondifferential optimization and polynomial problems* (Shor, 1998a) became a considerable scientific event. It contains the detailed review of non-differential optimization methods and its use in polynomial problems, great number of applications to discrete optimization problems, graph optimization problems, optimal Lyapunov functions, etc. It was found that in many cases the dual bound of nonconvex polynomial problem can be essentially improved by adding to the model new superfluous constraints which are consequences of initial constraints. In this book the reader will see many examples of such problems. Great attention is given regarding the information and numerical complexity of algorithms for solving polynomial extremal problems. Perhaps the most unexpected result is the connection of nonconvex polynomial problems with Hilbert's 17th problem regarding the representation of nonnegative rational form as sum of squares of rational forms. Shor found, that the dual quadratic bound for a given polynomial $P(x)$ has the same value as its global minimum P^* if and only if the polynomial $P(x) - p^*$ can be decomposed into the sum of squares of real polynomials.

He continues to be very active in research (see, for example, Shor, 1998b, 1999, 2001).

Professor Shor has won several awards including the USSR (1981) and Ukrainian (1973, 1993, 2000) State Prize for science and technology, and he received the Glushkov and Michalevich Prizes for his recent and continuing work to develop numerical methods for solving large-scale problems. He was elected as Associate member of the Ukrainian National Academy of Sciences in 1990, and became a full member in 1998.

He made a great contribution to the development of international scientific contacts in the field of optimization, particularly to dissemination of the results obtained by the scientists from the New Independent States.

Professor Shor's active educational work is tied to the Kiev Branch of Moscow Institute of Physics and Technology and National Technical University (Kiev Polytechnical Institute), National Taras Shevchenko University of Kyiv, International Solomon University. It should be mentioned that he always helped young scientists by attentive and benevolent scientific consultations and recommendations. He never limited the field of their researches by the main direction of the works accomplished in the department. Now Shor's 35 Ph.D. students are successfully working on different continents in different fields of applied mathematics.

Shor is a member of the Editorial Boards of four international journals on optimization.

We present below only a few among the 180 papers and 9 monographs he has written.

It is curious to note that in the recent years he did not touch the computer at all. Great experience in numerical methods and deep intuition permits him to feel all the details and guide the work of qualified programmers⋆ with fantastic professionalism.

We are happy on the occasion of his 65th anniversary to wish him a fruitful continuation of his rich scientific work.

Colleagues, friends

⋆ It is worth mentioning at least some of them: Nicolai Zhurbenko, Petro Stetsyuk, Oleksiy Lykhovyd, Farid Sharifov, Oleg Berezovski.

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