DECISION–MAKING SUPPORT SYSTEMS AS PERSONAL INTELLECTUAL DEVICE OF A DECISION–MAKER

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Abstract. The problems of the cognitive development of subject "perception" are discussed in the thesis: from the object being studied and means of action till the single system "subject – modus operandi of subject – object". Problems of increasing adequacy of models of "live" nature are analyzed. The concept of developing decision-making support systems as expert systems to decision-making support systems as personal device of a decision-maker is discussed. The experience of the development of qualitative prediction on the basis of polyvalent dependences, represented by a decision tree, which realizes the concept of "plural subjective determinism", is analyzed. The examples of applied systems prediction of ecological-economic and social processes are given. The ways of their development are discussed.

Keywords: practical knowledge; modus operandi; artificial intelligence; decision-making support systems; a decision tree; expert systems; decision-maker.

Pre-introduction

The author agrees with N. Bohr's thought, that "it's difficult to predict something, especially future". Why? It happens so, as representatives of the most theories, teachings and faiths reply that everything depends on non-controlled forces of outer world. It doesn't play a particular role how these forces are "shown up".

The representatives of "stochastic uncertainty" consider, that cause influence on consequence is determined as "objective probability" which comes to a person in the frequency of events occurrence. All this has the only sense under unlimited number of trials. A. Einstein (and we with him) objects to them: "I'll never believe that God himself plays dice".

Determinists, on the contrary confirm that consequence is defined by the cause unambiguously, "written on Heavens", though "God's ways are inscrutable".

Christian outlook admits "local" freedom of deliberate choice that means "does everything you should".

Atheistic doctrine suggests total dependency of future on human actions in the past and present. The main thing is to act in accordance with "objective laws", which "are opened" to the man in the practical activity process.

Many eastern esoteric teachings confirm that future is formed by human's wishes and will, which determine in their turn whether to accept or not the decisions, on the basis of which the situations with a person may appear. Though, contrary to the previous, "practical knowledge" is not the knowledge of activity management, but "knowledge of managing personal will".

Introduction

What is the role of "scientists" in the structure of modern mankind, studying the world and his place in this world? In particular, those who deal with the problems of "artificial intelligence"? While analyzing this question, first of all it's necessary to define the notion. According to George Luger [Luger, 2003, p.781] artificial intelligence (A.I.) to a less degree represents the theory of regularities, which is in the basis of logical behavior extending empirical methodology of creation and researching of models, which this theory is guided by. "The researchers gradually understood that intellectual programs should be inserted in topic field, but not cherished in the laboratory" [Luger, 2003, p.802]. The aim of scientists is to create instruments and "practical knowledge" thus this "knowledge is neither object nor subject" but "modus operandi of a subject" [Luger, 2003, p.806].

Narrowing the notion "object", "subject" and "modus operandi of a subject" to their narrow natural understanding, one may confirm, that the development of science of "new time" (from Decart, Newton, Leibnitz) resulted out of

isolated object studying (in the first turn on the basis of mechanics modules) and subject (psychology, sociology) and to some extend their interdependency (mathematical biology, mathematical economic theory) till their interaction (the way of acting subject under studying object, in particular, the object itself). In author's opinion, humanity (at any rate its "intellectual representatives") it's necessary to make one more step which is in transition to the creation of single system "subject – modus operandi of subject – object".

The peculiarities of "live nature" models

While modeling "abiocoen" processes the principles both determinism and stochastic uncertainty fully proved themselves. Thus, one may "with high degree of accuracy" (with "great probability") on the basis of mechanics laws and taking into account fortuitous perturbations to define rocket coordinates for "hours – days – years". The adequacy degree of social-economic processes modules, where the subject is "active multiplier" is incomparably lower. They have a very high degree of result uncertainty; moreover, this result often is senseless (i.e. in principal uncheckable). Thus, it refers both to normative models (which can answer the question "what should be done to achieve desirable?"), and positive ("what it will be?"). In [Voloshin, 2005] the analysis of decision-making problems is given and the means of their achievement are discussed. In particular, while creating mathematical and information models of socio-economical processes 2 main problems are emphasized – "subjectivization of objectivity" (direct consideration of subject influence on the decision-making process) and "objectivization of subjectivity" (compensation of influence of cognitive subject individual characteristics – taking into account his objective peculiarities of cognition reality).

In the given paper the emphasis is namely shifted to the "subject modus operandi" under the process of object cognition by the subject. At the same time the author tries to illustrate all approaches of "fighting with uncertainty", mentioned in "Pre-introduction".

Decision-making support system as expert system

In papers [Voloshin, Pikhotnik, 1999], [Voloshin, Panchenko, 2001], [Voloshin, Panchenko, 2002], [Voloshin, Panchenko, 2003], [Voloshin, 2005], [Voloshin, Golovnya, 2005], most of which were represented at KDS conferences, the concept of "qualitative prediction on the basis of polyvalent dependences, represented by a tree of decisions" is developed [Voloshin, Panchenko, 2002]. The basic idea of this concept is "plural subjective determinism". It's considered that corollary is determined by a set of interdependent causes, the degree of influence of which on corollary is defined "subjectively" (with expert measuring). The more parameters which "form" the cause, the better it is (for model adequacy), though this leads to complications in model analysis. Thus, appears "oath dimension", which is necessary to fight with [Voloshin, Panchenko, 2002], in particular with artificial intelligence methods.

In papers [Voloshin, Panchenko, 2003] and [Voloshin, Golovnya, 2005] the device system is described ("the aim of scientists is working out instruments", mentioned above) creating applied decision-making support systems (DMSS) in different spheres. The construction of applied DMSS is reduced to emphasizing problems and sub-problems (of tree knots) and connections between them (tree arches) by experts. Measures (probabilities) of transitions between knots are determined by experts. Fuzzy estimates of experts are assumed with the help of logical variables, described by assignment function values (by real numbers vectors from 0 till 1). Each expert assigns 3 estimates – optimistic, real and pessimistic, scalarization of which is performed with taking into account psychological expert type. This type is defined on the basis of psychological tests, inserted into system. The coefficients of "credibility", "independency" and "discretion" etc. are defined too.

The tree is composed on the base of expert's collective estimation with application of pair comparisons method. For constructing the resulting tree algebraic methods of processing expert information are used. As distance between rankings Hemming metrics and discrepancy function of objects ranks is applied. The resulting tree is defined as Cemeni-Snell's median:

$$Arg \min_{A} \sum_{i=1}^{n} d(A, A^i) \text{ or as a compromise: } Arg \min_{A} \max_{i} \sum_{i=1}^{n} d(A, A^i),$$

where A^i - matrix, assigned by the i[st] expert, in which element a_{ij} =1 then and only then when i – knot is more preferable for j – expert, a_{ji} = –1, for equal objects a_{ij} =0, a_{ji} =0.

In the case of assigned advantage in unclear form matrix elements are given by assignment functions.

For determining optimal paths in the variants of tree algorithms sequential analysis are suggested [Voloshin, Panchenko, 2002] letting to process trees with hundreds knots.

The decision tree is assigned by tables. Each table is a separate tree level; each line of a table is a separate knot at this level. Each element of line is probability with which transition from given knot to low level knot is possible. These probabilities are assigned by assignment functions, representing vectors of real numbers from 0 till 1 of any length. The table is filled with results of expert polling. The existing functions permit to add columns, lines, to assign vocabulary (which allows expert verbal values to be put in accordance with probability by assigning of definite levels), save tables in file, read tables from files.

Matrices are assigned by expert way. It's result of knot variants comparison, which may be inserted into tree. Knots are defined on the basis of matrices analysis, which are inserted into tree, and probabilities, with the help of which the transition from top level knots is possible. If the decision tree is decomposed into several sub-trees, which have similar leaves, at first probabilities of these leaves, are calculated in each of them, then probabilities for the whole tree in general are found out.

A number of applied systems is created – prediction of currency course, account of overall national product, diagnostics of cardiovascular diseases, prediction of index inflation etc. [Voloshin, Pikhotnik, 1999], [Voloshin, Panchenko, 2001], [Voloshin, Panchenko, 2002], [Voloshin, Panchenko, 2003], [Voloshin, 2005], [Voloshin, Golovnya, 2005].

At the KDS–1999 conference the result of calculation national currency course (hryvna) to 01.01.2001 was given, which was analyzed at KDS–2001. Prediction exactness turned out to be $\pm$ 2% at the time, when prediction of absolute majority of foreign and home, state and private organizations exceeded 50% (on both sides). The prediction of inflation index in Ukraine for 2005 – performed in June 2005 in diploma thesis of Satir V.V. equals 12,8%. In the budget of Ukraine was put 9,8%, official statistics on results of 2005 gives 10,5%, international organizations – 12,5-13%. High prediction accurateness, in our opinion, is stipulated by "objective" reason – accounting of a great number of heterogeneous interrelated reasons, influencing upon the result. While constructing the decision tree predicting course of exchange currency, economical, financial, political (changes in legislation, possible government retirements etc.) and other parameters were considered. These parameters characterize social-economic "state", both Ukraine and near abroad countries and the whole world system. The second reason, in author's opinion, is "subjective" – this is highly specialized expert estimation. The expert very often even doesn't aware what finally he predicts.

Developing models of qualitative prediction on the basis of decision tree have one more interesting peculiarity, which was marked so far by Popper in 1959 [Luger, 2003] – "scientific theories have to make mistakes". In other words, there should be conditions, under which the model can't approximate phenomenon successfully. It happens so, because for confirmation of model correctness any finite number of approved experiments is not sufficient. Mistakes in existing models have to stimulate further research. The considering model corresponds to this in full measure. If predicted value doesn't correspond to reality, it means that either some of factors are not taken into account (which appeared probably on the prediction interval) or the extents of parameters influences are estimated wrong (which could be done correctly in the future). So, the principle of "reason influence on the corollary" is to be rejected.

DCSS as personal intellectual device of a decision-maker

While using developed device, described in the previous chapter for developing disease diagnostics applied systems [Voloshin, Golovnya, 2005], the restrictions in adaptability of used DC as expert systems, which average experts knowledge and experience, were finally defined. Thus, while diagnosing the most difficult for psychic

diseases, "experts" from Moscow and Saint-Petersburg schools (both are world – recognized) often estimate the parameters interference degree by an alternative method. In that way we get an "average hospital temperature".

As a result we came to the following conclusion of DMSS development – DMSS system shouldn't be an expert system, but an intellectual booster of a decision-maker; in other words "personal intellectual device" DM. Communication with doctors-diagnosticians (particularly with our collaborator in [Voloshin, Golovnya, 2005]) convinced us, that all of them consciously or subconsciously follow "the theory of inserted and executed action" [Luger, 2003], i.e. "experience of the action" (mentioned above). The following two considerations are appropriate here. Firstly, according Worldwide Health Organization data the death caused by the wrong diagnosis placed fifth in the world. Second, from Avicenna time, who claimed that "doctor is a person, who treats from the disease and he knows very little about it; he treats with the help of drug, about which he knows even less a person, whom he doesn't know at all", a few things changed. What is the solution? "To model" the DM action (in this case a doctor), but not construct the model based on his knowledge. Thus, the experienced doctor considers tens and hundreds of parameters, whose correlation and interference he could not estimate in principle. Therefore, he has nothing to do but to make out "main" parameters, rejecting the "secondary" ones. But this could lead to the unpredictable results. Communication with the experienced doctor, who has observed hundreds of patients, confirmed our conception about principle of "inserted" action during diagnosing. The diagnosis is determined exactly on the basis of construction (conscious or subconscious) of the decision tree. Therefore, the task is to provide DM with a device for representation and processing of "his" decision tree. It is important to note here, that the information about the decision, tree while determining diagnosis, may be of confidential character. If obtained computer diagnosis doesn't coincide with the intuitive idea of DM (or with the "true" diagnosis, established by pathologist), then it's necessary to provide feedback means realization for tree correction; in particular, to elaborate efficient algorithmic procedures of tree analysis on sensitiveness. It is our first important task while developing the described approach.

Conclusions

Not rejecting the necessity of creating decision-making support systems as expert systems, the author is sure in expanding of usage sphere of decision-making support systems as "personal intellectual device systems", "which are aimed" at concrete user. In the first turn, it's concerned with "creative" spheres of human activity (as example medical diagnosis can be). Here the analogy with the history of appearance and development of personal computers is essential.

Bibliography

[Люгер, 2003] Люгер Ф.Дж. Искусственный интеллект. Стратегии и методы решения сложных проблем. // Москва: «Вильямс»,2003.-264с.

[Волошин, 1999] Волошин А., Пихотник Е. Экспертная система прогнозирования курса гривны // "Искусственный интеллект", 1999, №2. – С.354-359 (укр.).

[Волошин, 2001] Волошин А.Ф., Панченко М.В. Прогнозирование нестабильных процессов с помощью дерева решений на основе метода парных сравнений для анализа экспертной информации // Труды конференции «KDS-2001»,Том 1, Санкт-Петербург, 2001.-С.50-53 (англ.).

[Волошин, 2002] Волошин А.Ф., Панченко М.В. Экспертная система качественного оценивания на основе многопараметрических зависимостей // "Проблемы математических машин и систем", 2002, №2. – С.83-89 (укр.).

[Волошин, 2003] Voloshin O.F., Panchenko M.V. The System of Quality Prediction on the Basis of a Fuzzy Data and Psychografphy of the Experts // "Information Theories & Applications", 2003, Vol.10, №3.-P. 261-265.

[Волошин, 2005] Волошин А.Ф. О проблемах принятия решений в социально-экономических системах // Труды конференции «KDS-2005»,Том 1, София, 2005.-С.205-212.

[Волошин, Головня, 2005] Волошин А.Ф., Головня В.М. Система качественного прогнозирования на основе нечетких данных и психографии экспертов // Труды конференции «KDS-2005»,Том 1, София, 2005.-С.237-243.

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