FUZZINESS OF THE INTELLIGENT SYSTEMS FUNCTIONING, BASING ON THE DECISION-MAKING PROCESSES

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The basic prerequisities of fuzzy principles of intelligent systems functioning are the following ideas:

1. It is well known that the main brain function is to define the cause-effects relations in the environment, so the problems of probabilistic, fuzzy determinacy play extremely important role in the human behaviour, especially intelligent behaviour providing human intelligent behaviour.
2. Brain structures as the leading contral and information system in the living organisms are capable not only receiving, handling, and storing the input sensory information but also increasing it or even creating, producing new information (some kinds of creativity). It explains the necessity to keep in mind that a definite information content of environment signal may be associated with some different information values depending on the conditions and functional state of living beings. It may explain neurophysiological basis of creativity as a main composite elements of natural intelligence, including elements of fuzzy logic and fuzzy algorithms.
3. The human everyday practice of the naturallanguage usage is the main factor for explaining the multivalued, probabilistic or even fuzzy logic of human mental activity, fuzzy principles of natural intelligence manifestation. For the first time it is connected with many-valued relations between sign and denotation inherent to all natural languages.

The higher forms of creative intelligent activity performed by a man on the ground of decision-making processes are the fuzzy algorithms of purposeful acts (Chorayan, 1979, 1987, 1994; Takagi, 1990; Yager, 1990). In its turn esential uncertainty in the decision-making process is closely connected with the peculiarities of cause-effect interrelations having significant role in intelligent behaviour. The investigation of determinacy of phenomena is one of the central aspects of any science to clarify cause-effect of the observed processes of regularities and laws of nature. Determinism is a general theory postulating universal regular interrelations of all the phenomena of the real world and rejecting the existence of any phenomena or objects beyond these universal bonds. New discoveries in many fields of science, particularly in the science dealing with living systems, reveal new specific features of determinacy , thus showing the inexhaustibility of the material world.

In the complex ever-changing world vital and important events cannot be predicted unambiguously, they can be anticipated with greater or less

degreee of probability. Therefore the process of natural selection gave advantage to such organisms which could have the purposeful behaviour in accordance with these probabilities on the basis of fuzzy logic. The human brain control behaviour underlayed the different forms of intelligent bahaviour may be considered as a result of the thinking process based on the universal mechanism of decision -making and can be attained only within a certain degree of uncertainty and vagueness. The central key mechanism in decision-making is a probabilistic or even fuzzy logic process of eliminating redundant degrees of action freedom, a process in which the probability of the chosen alternative is a function of usefulness. The distinguishing property of human intelligent activity is absence of precise description, strict formalization. The main advantage of human brain is his capability of handling with vague concepts. Vagueness is a fundamental property of human thinking.

In a number of practical cases of intelligent behaviour realization where essential information uncertainty precludes the correct use of classical methods of the statistical decision theory and the probability theory a possible solution could be gained only by using the fuzzy sets theory or the theory of possibilities (Zadeh, 1981; Kauffman, 1975). Both these theories have been widely used in many scientific applications (Negoita, Ralescu, 1975; Gaines, 1976; Chorayan, 1979). These investigations claim that this approach could successfully be upplied to solving problems in taxonomy, character or speeech recognition, machine translation, and logical deduction based on the fuzzy input data, etc.

The elements of fuzziness are essentially presented in information activity of the central nervous system. It is connected with different approaches to the information contents of message. In the general information theory three aspects are distinguished at present: statistic (studying statistics of sign elements), semantic (analyzing the message contents), and pragmatic (dealing with estimation of the message from the standpoint of its content in conformity with the particular goal). Semantic information can be regarded as knowledge obtained from a particular message. Such approach implies that the information about the way of coding (metainformation) is contained in the thesaurus
of the information receiver.The determination of the message value and its quantitative evaluation (from the standpoint of its content) are associated not with the objective estimation of the message itself but with its fuzzy psychological interpretation, taking into account individual differences of the receiver's thesaurus.

In order to study the dynamics of the useful information in neuro- and psychophysiological manifestations of an organism's different kinds of intelligent behaviour following equation was applied:

$$I_{sem} = \sum \log_2 \frac{P_i}{P_o} ,$$

where p_o is probability of the event before and p_i - after the occured event (realization of some intelligent behaviour sample).

Instead of p_i the Bayes probability is taken:

$$P_i = P_{Ai}(K) = \frac{P_o \cdot P_{Ai}(K)}{\sum P_o \cdot P_{Ai}(K)} ,$$

where $p_{Ai}(k)$ is probability after the occurred event k .

Dynamics of the informational changes in psychophysiological manifestations during intelligent behaviour realization showed an essential growth of semantic information values. These results illustrate interesting fact: semantic information is formed not only owing to input information but also by transformed part of the information kept in a system's memory and in some way associated with the message coming from the outside by using the informational thesaurus of the system. Obviously it is one of the essential reason of vague, fuzzy relation forming between the sensory signal, message content and the knowledge developed under this message influence. Such vagueness, fuzziness of subject information thesaurus is considerably connected with the uncertainty in memory mechanisms.

In accordance with above-mentioned it is interesting to consider the different aspects of applying the theory of fuzzy sets to the study of pattern recognition or memory. It is considered in a number of works (Siy, Chen, 1974; Shimura, 1975). In the case of associative memory as the distributed memory let's we have

$x^M = \{ x_1^M, x_2^M, \ldots, x_n^M \}$ as the n- dimensional incoming pattern. The individual components of the pattern are accumulated in the memory elements in the form of the fuzzy matrix and if necessary are extracted from the memory by some key pattern:

$$Q^M = \{ q_1^M, q_2^M, \ldots, q_n^M \}$$

in accordance with the particular value q.

Such approach may be used in the various cases of pattern recognition. The method of the integral estimation of belonging of the analyzed pattern to the "standard" (taken as the analogue) is realized on the basis of possibility calculation by operating with the concept of fuzzy sets approximating the varieties of the classes of identified pattern features.

Solving many problems of the human everyday life associated with thought activity is usually carried out in situation not liable to precise quantitative description. One of the practical application decision-making principle is the finding of optimizing teaching schemes, programs, curricula. Constantly increasing volume of knowledge needs the optimization as entire volume of teaching so experimentally and theoretically substantiation of the excepted consequence subject sections presentation. In connection with it one of the most problems of the university teaching process including postgraduate courses is solving optimal teaching programs, distinguishing leading and accessory sections of the subject. This problem is carried out usually with expert assessment usage. However selection of the experts, essential subjectivity of such assessment, and large difficulties even impossibility of precise evaluation don't allow to apply the classic method of probability and statistic theories.

Let's consider an example of fuzzy sets theory basic statements to description of some important sections of the subject with expert assessment usage. For example we have 5 sections of some subject (A_1, A_2, ..., A_5). To evaluate the meaning of these sections an expert takes into account 4 criteria: Q_1 - information thesaurus, Q_2 - readiness of students to accept this section of the subject, Q_3 - availability of appropriate didactic methods to present this section, Q_4 - a value of this section to deepen the students further knowledge. Each of the section is evaluated on 0-1 scale in relation to chosen criteria. In result we receive some conditioned measurements defined by the numerical values of membership function for every section characterizing a level of this section belonging to fuzzy set approximating above-mentioned criteria. The section characterized with the maximal value of membership function (according to the considered characteristics) may be defined by fuzzy sets intersection operation (Zadeh, 1978): $\bar{Q} = Q_1 \cap Q_2 \cap Q_3 \cap Q_4$.

Such procedure of optimal choosing under multiparameter alternatives assessmenmt may be applied only in the case of equal values of indices and properties taken into account. However in the real cases of expert assessment the validity of the separate experts is diverse . The comparative validity of evaluation may be estimated using the concentration operation of fuzzy sets: Con $A = A^2$.

In general way to choose the optimal mean of goal fulfilment we use the method described by Nekola and Vitek (1990). Let' s we have fuzzy sets approximating some goals (I) and some means (J) of its fulfilment. Then efficiency of the j-th mean is described as:

$$E_j = \sum_i a_i b_{ij} \; ; \quad e_j = \left(\sum_i a_i b_{ij} / \sum_i a_i \right),$$

where a_i is the weight of the i-th goal (I = 1,.....,n; j= 1,...,m)

e_j is medium value of contribution for the goal fulfilment,

b_{ij} is the contribution of the j-th mean for i-th goal.

It is clear that this method may be successfully used for the wide class of problem situation solving in the intelligent behaviour samples.

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