Received 26.03.2014

HUMAN BEHAVIOR SIMULATION BASED ON THE SUBJECTIVE VIEW OF CHOICE SITUATION

G.P. Vinogradov, Dr.Sc. (Engineering), Professor
(Tver State Technical University, Quay Nikitin 22, Tver, 170026, Russian Federation,
wgp272ng@mail.ru)

Abstract. The article considers a model of decision making based on subjective views on choice situation. The views are the result of cognitive activity. They are described in the form of a mental image as the result of perception. They are represented as a model of knowable and analyzed objects, processes, phenomena and are consciously accessible. Agent's attitude to the observed and analyzed data is formed according to the generated model and based on attitudes, rules, past experience, knowledge fixed in the consciousness. Then, depending on this relationship, a subject forms his behavior. He also develops his own program of actions in the events, phenomena that he considers important. A normative (rational) or behavioral decision-making model is used to describe a decision-making process. Recent research of the decisions making theory has shifted from selection processes description (using normative models) to actual procedures of decision-making. These procedures use formalization of methods and approaches developed within cognitive psychology and information processing theory. The shift of the research emphasis is related to examination of the discrepancy reasons between actual and optimal choice. It is important to form the corresponding reflexive control. The proposed approach is based on agent's choice simulation methodology. This methodology is developed by extending classical decision-making models using formalisms concepts of psychology and sociology. The methodology involves description criteria for used terms and corresponding measures. The apparatus of fuzzy and rough sets is used to create these measures. Introduced measures can be assessed by observing the agent's behavior. The author introduces the definitions for functional properties that characterize the choice and behavior of the agent. He also forms a selection model using subjective views on the choice situation.

Keywords: modeling, choice situation, decision-making model, agent, multi-agent system.

УДК 519.8 Дата подачи статьи: 26.03.2014

МОДЕЛИРОВАНИЕ ПОВЕДЕНИЯ ЧЕЛОВЕКА С УЧЕТОМ ЕГО СУБЪЕКТИВНЫХ ПРЕДСТАВЛЕНИЙ О СИТУАЦИИ ВЫБОРА

***Виноградов Г.П.**, д.т.н., профессор (Тверской государственный технический университет, наб. Аф. Никитина, 22, г. Тверь, 170026, Россия, wgp272ng@mail.ru)*

Аннотация. Рассматривается модель принятия решений агентом на основе субъективных представлений о ситуации выбора, которые являются результатом его когнитивной деятельности. Они формируются в виде мысленного образа как результат восприятия, представляют собой модели познаваемых и анализируемых объектов, процессов, явлений и наиболее доступны сознанию. В соответствии с моделью, сформированной исходя из фиксированных в сознании установок, правил, прошлого опыта, знаний, агент вырабатывает отношение к наблюдаемому и анализируемому. Затем в зависимости от этого отношения формирует свое поведение, вырабатывая программу действий и определяя степень своего участия в событиях и явлениях, которые он считает важными. Для описания процесса принятия решения используется либо нормативная (рациональная), либо поведенческая модель принятия решения. Исследования в области теории принятия решений в последние годы изменили свое направление от описания процессов выбора с помощью нормативных моделей к изучению фактических процедур принятия решений путем формализации методов и подходов, развитых в рамках когнитивной психологии и теории обработки информации. Это обусловлено необходимостью исследования причин несоответствия между фактическим и оптимальным выбором и формирования соответствующего рефлексивного управления. Предлагаемый подход основан на оригинальной методологии моделирования выбора агентом, разработанной путем расширения классических моделей принятия решений включением в них формализмов понятий психологии и социологии. Согласно ей водятся параметры описания используемых понятий и соответствующие им меры. Для построения мер используется аппарат теории нечетких и приближенных множеств. Оценки по введенным мерам могут быть получены путем наблюдения за поведением агента. Вводятся определения функциональных свойств, характеризующих выбор и поведение агента. Сформирована модель выбора, использующая субъективные представления субъекта о ситуации выбора.

Ключевые слова: моделирование, ситуация выбора, модель принятия решений, агент, многоагентная система.

Human behavior (hereinafter purposeful agent – CA) is the result of his cognitive activity. In psychology, cognitive activity is regarded as forming a mental image (the result of perception) and models of knowable and analyzed objects, processes, phenomena. According to generated model and based on fixed mind installations, rules, customs and past life experience, knowledge, the subject produces his own attitude to the observed and analyzed. Then the subject forms his behavior. It depends on this attitude and adequacy degree evaluation between the object and the result of mental visualization and analysis. He also develops own action program (he can vary degree of his participation up to the complete non-participation) in the events, processes, phenomena, which he considers important for himself. Therefore, one of the approaches to overcome the shortcomings of traditional methods of describing the agents' behavior in organizational systems is the modification of rational behavior models. It is achieved by including the so-called unobserved variables. They are characteristics of human behavior used in psychology, sociology, etc. For example, we introduce the r parameter. It will characterize the type of an agent, and $r \in B$ (r otherwise can be called the agent characteristic) [1]. The objective function of $f(\bullet)$ agent will depend on the environment state $\theta \in \Omega$, performance $o \in A$, that achieved by implementation of the agent's action $c \in C$, management of the center $u(\bullet) \in U$ and r type agent. If we follow the hypothesis of rational behavior of an agent, then the agent will try to get a result $o^* \in A_o$ that will maximize his objective function $o^* = \operatorname{Arg} \max_{o \in A,\, c \in C} f(o, u, c, \theta, r)$. This allows us to speculate about the function $f(\bullet)$ with information: $s = F(\theta \in \Omega_o, z = G(o) \in A_o, q = H(c) \in C$. This approach must use some idealized design (model) that describes the behavior of CA in decision-making.

Purposeful behavior model

Purposeful behavior is always associated with the selection that occurs in a situation of purposeful state [2–4]. Purposeful state consists of the following components.

- Entity that makes a choice (purposeful agent – CA).
- Selection setting (S), which is represented by the set of elements and their essential properties. Any of property changes may cause or produce a change in the purposeful choice state.
- Available action methods $C_{ij}^k,\ j = \overline{1, n}$, of k-th agent, which he owns and can use to achieve the i-th result (also called alternatives).
- Possible surrounded by S scores (significant for CA) – $O_i^k,\ i = \overline{1, m}$.
- The method of evaluating properties of the obtained results when choosing the mode of action.
- Restrictions that reflect the requirements to the output variables and control actions, imposed by the purposeful choice situation.
- Subjective decision-making situation model. It is represented as a set of relations describing the dependence of control actions, parameters and disturbances with the output variables.

For described components we introduce measures that will be used to assess the purposeful state.

1. We assume that the CA is able to allocate factors. They are environment characteristics $X^k = \{x_i^k,\ i = \overline{1, N}\}$. The CA evaluates influence of each factor using linguistic variable "factor influence degree" $\mu^k(x_i^k) : x_i^k \to [0, 1]$.

CA formalizes the ideas about the influence of selected factors on the results $O_i^k,\ i = \overline{1, m}$. We assume that for this purpose the CA uses an approximation in the form of production rules, which are as follows:

If x_1 is A_{r1}^k and if x_2 is A_{r2}^k ... and if x_N is A_{rN}^k, then $O_i^k = f_{ir}^k(x_1, x_2, ..., x_N),\ r = \overline{1, R},\ i = \overline{1, m}$, (1)
where R is a number of production rules, r is a number of current production rule, $O_i^k = f_{ir}^k(x_1, x_2, ..., x_N),\ r = \overline{1, R},\ i = \overline{1, m}$ is a clear function. It reflects the CA's view of functional relationship of input factors with possible results for the r-th rule; A_{ri}^k is fuzzy variables defined on $X^k = \{x_i^k,\ i = \overline{1, N}\}$.

2. The modes of action that are known (available) by CA. C_j^k is a function of the environment state parameters taken into consideration by the CA, functional and morphological properties of the system. Then a set of assumptions about their possible values forms a scenario of a possible environment state, system functionality and possibility of morphological changes in the system. For example, the implementation of scenarios with rules (1) allows forming an idea of the possible outcome $O_{ij}^k,\ j = \overline{1, m^k}$. Hence, it determines the nonequivalence when choosing the mode of action that can be described as the confidence degree of the necessity of mode of action. This estimate can be described by linguistic variables $\psi_{ijl}^k(O_{ijl}^k,\ C_{jl}^k) \in [0, 1],\ l = \overline{1, m^k}$. This measure is an individual characteristic of the CA. It can be changed as a result of learning and gaining experience.

3. Possible results for a given choice environment. When the agent makes a decision in a purposeful state situation to achieve a result, the choice of mode of action is connected with quantitative assessment of selected decision properties as shown in [5]. Selecting a list of properties and their parameters depends on the CA. We represent the possible outcomes for a given choice environment of CA as $O_i^k \in \{O_{ij}^k, j = \overline{1, J}\}$, where O_{ij}^k is a set of possible outcomes when choosing the j-th mode of action, $i \in I$ is a set of results taken into account by k-th CA.

4. Value of the results. The CA is able to compare the benefits that he gets when receiving different types of stimulation results with labor costs to achieve this. This assumption determines the existence of the indicator. The value of j-th result type can be evaluated using the following linguistic variable $\varphi_i^k(O_i^k(C_j)) \in [0, 1]$.

5. Effectiveness in the context of the result. It is a linguistic variable. It expresses the CA's individual assessment of the consequences of the choice regarding costs: financial, material, labor, labor intensity. E_{ij}^k is a degree of certainty, that some mode of action C_j^k will lead to a result O_i^k in S environment, if the CA will choose it.

$$E_{ij}^k = E_{ij}^k(O_i^k \mid A \text{ choose } C_j^k \text{ in } S) \in [0, 1].$$

It allows evaluating the effectiveness of the method chosen by the CA.

6. We define the value of a purposeful state of i-th result for k-th CA according to Sugeno rule [6]:

$$E\varphi_i^k = \frac{\sum_{j\in J} \varphi_{ijl}^k (O_{ijl}^k (C_{il}^k)) \bullet \psi_{ijl}^k (O_{ijl}^k, S_{ijl}^k)}{\sum_{l=1}^{m} \varphi_{ijl}^k (O_{ijl}^k (C_{il}^k))}.$$

We can similarly estimate the value of a purposeful state for k-th CA according to the efficiency for i-th type of results:

$$EE_i^k = \frac{\sum_{j\in J} EE_{ij}^k (O_i^k (C_i^k)) \bullet \psi_i^k (C_j^k)}{\sum_{j\in J} \psi_i^k (C_j^k)}.$$

7. CA's evaluation of purposeful state desirability using i-th result and its achieving efficiency in a choice situation is defined as a linguistic variable $\chi_{i1}^k = \chi_1^k (E\varphi_i^k) \in [0,1]$, $\chi_{i2}^k = \chi_2^k (EE_i^k) \in [0,1]$.

The basis of the interaction between individuals and organizations is psychological and economic contracts. They reflect significant expectations of a person and relevant expectations of the organization. Consequently, we can define the following constraints: $\sum_i \chi_{i1}^k (E\varphi_i^k) \ge \chi_1^0$ and $\sum_i \chi_{21}^k (EE_i^k) \ge \chi_2^0$, where χ_1^0 and χ_2^0 are expectations of the CA from the organization, which reflect the balance between costs and rewards for achieved results.

When a reward function is fixed, according to the rational behavior hypothesis the CA generates a decision as $P_i(S) = \text{Arg}\max(E\varphi_i(s_i, c_i)),\ s_i \in S_i$, $c_i \in C_i(I_t^i),\ I_t^i \subseteq M,\ \chi(E\varphi_i) \ge \chi_0$, where χ_0 is an assessment of maximum win, which the CA could obtain by performing other work. If $\chi(E\varphi_i) < \chi_0$, we should expect that CA will choose c_i=0.

These rules mean that there is a CA that wants to get some result. It has several alternative ways to achieve the result with different efficiency. And its confidence in getting the desired result is significant.

Fuzzy description model for agent's purposeful behavior

A goal is accomplished by tasks. And tasks are accomplished by outcomes [6, 7]. An outcome defines a desired result for the agent in a short period of time in certain s choice environment:

$$I(t,s) = \text{Arg}\max_{t_1 \le t \le t_2} \{EV_k^t (O_k^t, t, s, c_k^t) \big| O_k^t \in O,\ j \in J,$$
$$s \in S,\ c_k^t \in C,\ t_1 \le t \le t_2\}.$$

The task is the last desired result for the agent in the sequence of results $I(t,s),\ t_1 \le t_i \le t_m$. With $I_1(t_1, s_1) < I_i(t_i, s_i) < \ldots < I_m(t_m, s_m)$. It means that the task is described as following:

$$Z(t_m, s_m) = \max_{t_1 < t < t_m} \{I_k(t,s) \big| t_1 \le t \le t_m,\ s \in S\}.$$

The goal is an unattainable result W. But it can be infinitely close in the sequence of tasks $Z_v(t_v, S_v)$ in time interval $t_1 \le t \le t_v < t_n$. Moreover $Z_1(t_1, S_1) <$ $< Z_2(t_2, S_2) < \ldots < Z_v(t_v, S_v) < Z_n(t_n, S_n) = W^*$ and the reasonableness of achieving the goal is $P_v\{Z(t_v, S_v) \ge Z_n(t_n, S_n)\}$ (the membership function "reasonableness"). It approaches as n increases to 1 with no limit. This follows from progressivity properties of the purposeful intelligent system [2, 7].

Advancing the task, the expected specific value regarding the result O_k^t increases monotonically in the time interval $t_1 \le t \le t_2$. And advancing the goal at the time interval $t_1 \le t \le t_v < t_m$:

$$I_m(t_m, s_m) > I_{m-1}(t_{m-1}, s_{m-1}),$$
$$Z_v(t_v, S_v) > Z_{v-1}(t_{v-1}, S_{v-1}).$$

Advancing the goal and the task, the majority of available actions for an agent and the set of possible outcomes can be fixed. When there is a need to create new ways of actions and new results in addition to old, their online search is organized. Then

$$I(t,s) = \text{Arg}\max_{t_1 \le t \le t_2} \{EV_{jk}(O_j, t, s) \big| O_j(C_i) \in O,\ j \in J,$$
$$O \in \{O\}, C_i \in C, i \in I, C \subset C', s \in S\}. \qquad (2)$$

Model of agent's submissions about the purposeful choice state

A purposeful choice situation can include: M is constraints, C is modes of action, i is normative or ideal elements, ie is a symbolic expressions of normative or ideal elements, Ω is an external environment. For the agent a purposeful choice situation exists in the form of representations. The agent forms a representation using following components:

- available ways of acting;
- possible outcomes from this acting;
- possible states of the choice environment (possible values of uncontrolled variables that may affect the results of using modes of action, including representations of other agents);
- probabilities that each possible state of choice environment is true;
- the efficiency of each available mode of action for each possible outcome in every possible state of choice environment;
- specific value of each possible outcome.

There is a special aspect in forming representations by an agent. He uses not only the results of external environment monitoring, but also the results of monitoring the actions and results of other agents as an information for adjusting his perceptions about uncertain parameters. He tries to "explain" why they chose those actions.

Let $\theta \in \Omega$ is a nature state. The agent with the number $k \in K$ has interval information about this nature state. It is $\forall \theta \in \Omega,\ \forall k \in K,\ \theta \in \omega_k(\theta)$.

The result of the system $o=G(\theta, c)$ depends on the vector $c=(c_1, c_2, ..., c_k)\in C'=\prod_{k\in K} C_k$ of other agents' actions associated with the k-th agent, $c_i\in C_i$, and θ are nature states. We assume that the specific value of each agent's choice depends on θ nature state and o result of the system: $EV_k(o) = f_k(\theta,\ G(c,\theta)),\ k\in K$. We consider that K set of agents, their results $\{O_k(\bullet)\}$, $\{C_k\}$ set of feasible action, Ω set of possible values of nature states and $G(\bullet)$ function is a common knowledge. Each agent observes the action vector of all agents, the overall result and the results of all agents.

The overall result and the specific value of each agent's results depends on the actions of all agents (2). That is why we can use the game theory apparatus to describe their behavior.

We denote the set of parametric Nash equilibrium (a parameter is the nature status value) as:

$$E_N(\theta) = \{\{c_k\}_{k\in K} \in C' \mid \forall k\in K,\ \forall x_i \in C_k$$
$$f_k(\theta,\ G(\theta, c_1,...,c_k)) \ge$$
$$\ge f_k(\theta,\ G(\theta, c_1,...,c_{i-1}, x_i,..., c_{i+1},...,c_k))\}.$$

If a set $\Omega_0\subset\Omega$ of possible nature status values is common knowledge among agents, then we obtain the following set of game equilibrium (assuming that they eliminate the uncertainty by calculating the maximum guaranteed result):

$$E(\Omega_0) = \{\{c_k\}_{k\in K} \in C' \mid \forall k\in K,\ \forall x_k \in C_k$$
$$\min_{\theta\in\Omega_0} f_k(\theta,\ G(\theta, c_1,...,c_k)) \ge$$
$$\ge \min_{\theta\in\Omega_0}\ f_k(\theta,\ G(\theta, c_1,...,c_{i-1}, x_i,..., c_{i+1},...,c_k))\}.$$

We denote $q(c)\subseteq\Omega$ as a set of nature states, when the vector of agents' modes of action is an equilibrium: $q(c) = \{\theta\in\Omega \mid \exists\Omega_0 : \theta\in\Omega_0\}$.

We denote $g = (g_1, g_2,..., g_n)\in\Re^n$ as the vector of result values for agents, they consider it satisfying.

When the specific values of the agents' choice results g are the maximum (along with the observed o result), the set of nature status values is the following:

$$\eta(g,o) = \{\theta\in\Omega \mid f_k(\theta, z) = g_k, k\in K\}.$$

$g = (g_1, g_2,..., g_n)\in\Re^n$ vector is determined by EV_k for each $k\in K$. Then $V = \{v_1,...,v_k\}\in\Theta^n$ vector determines the required level of agents' representation in a purposeful choice situation.

According to [7] we assume that the agent is subjectively rational:

1) his interests are expressed as subjective value assessments $\varphi_{ij}(O_i(C_j))\in[0, 1]$ of expected results $O_i, i=\overline{1,n}$ using modes of action $C_j(\theta, E), j=\overline{1,m}$ based on Ω purposeful choice situation representation;

2) agent's behavior rationality involves striving to maximize the specific value of expected results. The agent chooses the mode of action under uncertainty and when the information is incomplete.

While analyzing, the agent forms his own view of the choice situation as a hypothesis. He also considers the significance degree for the observed parameters and classifies them as for or against evidence. Then the agent searches for data to support the hypothesis and deny it. However, he uses only data that is necessary and sufficient for understanding the processes in his subject domain.

If the facts refute the hypothesis, the agent modifies or revises it and includes the positive aspects from the old hypothesis. Data analysis allows generating questions (queries) to confirm the assumptions, information search for the answer. It is the basis for acceptance or rejection of the original submission. This strategy allows forming a consistent relationship between the observed parameters and agent's representations when the source data is incomplete and unreliable.

Definition 1. The agent is confident in his representation adequacy in the Ω type choice situation for G goal. And based on this he considers the choice of C mode of action helpful to achieve G goal. In this case:

1) the agent perceives a part of X situation characteristics for Ω choice;

2) for the other part of X situation characteristics he makes assumptions and shows the intention to prove (verify) their credibility;

3) in similar Ω type choice situations the agent always achieved G, when perceiving the presence (absence) X and aiming for G choosing C;

4) when the agent observed the absence (presence) of X in Ω choice situation, he never chosen C to achieve G goal based on this submission.

The assumption is a default value of the observed characteristics or a description of a causal effect between the observable characteristics.

Agent's representations are characterized by conviction level.

Definition 2. The agent is sure of his perceptions of Ω type choice situation for G goal. His conviction level is determined by the achievement frequency of G goal when choosing C mode of action based on his perceptions.

Assessing the level of conviction varies from zero to one. If the number of unsuccessful attempts to achieve the G goal with C mode of action based on agent's representations increases, then the level of conviction decreases (and vice versa). It becomes a trigger for the agent to make efforts for modifying representations or their complete reconstruction. It is a result of increasing doubts about the plausibility of made assumptions.

The desire to verify the correctness of the assumptions is a measure of agent's doubt.

Definition 3. The agent makes efforts to prove (disprove) an assumption. These efforts define the extent of his doubts about the submissions of Ω type choice situation when aiming to the G goal.

The definition 2 says that the level of conviction depends on the number of confirmations of the correct choice based on the submissions. According to theory of behavioral psychology, if this level increases, then the agent's desire of verifying falls. The agent sees no sense in it. On the other hand, increase of the agent's degree of doubt is a trigger to find additional arguments (counterarguments).

The degree of conviction is a parameter that takes into account these two characteristics:

$S_u = U_u^{\alpha} * (1 - S_s)^{\beta} \in [0, 1]$, $\alpha+\beta=1$,

where S_u is a degree of conviction, U_u is a level of conviction (past experience), S_s is a degree of the agent's doubt about the correctness of his perceptions of the choice situation, α and β are coefficients of significance for the agent's experience and the necessity of evidence search.

Assumption 1. When forming their views, agents use the argument apparatus to create a sequence of hypotheses converging to subjectively true [8].

Assumption 2. When considering the A event that is occurred, the agent believes that the B event is a cause. On the other hand, observing the A event, the agent makes a conclusion about the possibility of the B event.

At the k-th agent has the following data sources about the state of the environment [9]:

1) prior private information $\omega_k(\theta) \subseteq \Omega$ (this type of information is called knowledge, experience);

2) the actions of other agents. Observing and assuming that the opponents act rationally, the agent can (with assumption of common knowledge) to asses $q(c)$ information about nature state. Based on this information the choice of mode of action was made by the i-th agent ($i \neq k$);

3) the g set of agents' choice results. This information helps agents to make a conclusion about nature states when the observed result leads to the observed winnings;

4) the set $\rho \subseteq \Omega$ of nature states, when the observed vector of agents' actions leads to this observed o value of the system result: $\sigma(c, o)=\{\theta \in \Omega | G(\theta, c)=o\}$.

According to the assumption made above, the information in 2–4 entries is a common knowledge for agents. Then the following relation is fair:

$I(c, o, g)=q(c) \cap \sigma(x, o) \cap \eta(g, o) \subseteq \Omega$.

Based on the common knowledge and their own views each k-th agent can calculate the estimate of $J_k \in \Omega$ nature state value as the intersection of the $I(c, o, g)$ common knowledge with its private information ω_k:

$J_k(\omega_k, c, o, g) = \omega_k \cap I(c, o, g)$ [10].

We assume that $c_k^t \in C_k$ is a mode of action of k-th agent to reach a result on step t, c^t is a set of vectors of all agents' actions in t steps. At the moment of reaching a result on step t the common knowledge among agents is:

$I(c^t, o^t, g^t)=q(c^t) \cap \sigma(c^t, o^t) \cap \eta(g^t, o^t) \subseteq \Omega$.

Based on all sources of information k-th agent in t periods can calculate the estimate of $J_k^t \subseteq \Omega$ value of the nature state as the intersection of the $I(c^t, o^t, g^t)$ common knowledge, with its private information J_k^{t-1} that corresponds with the previous period:

$J_k^t = J_k^{t-1} \cap I(c^t, o^t, g^t)$.

Due to the rise of the specific value of the result for the agent when achieving the goal and according to the agent's representations formation properties $\nu_k^t(J_k^t) < \nu_k^{t-1}(J_k^{t-1})$, where $\nu_k^t(\bullet)$ is evaluation of agent's conviction in the adequacy of his representation structure.

Thus, when the hypothesis of rational behavior and the hypothesis of common knowledge is true, there will be a convergent process of forming representations of the agent.

Evaluation of awareness for the fuzzy choice problem

When information and knowledge is incomplete, or there is a lack of time, the agent creates a model of the subject domain temporarily based on plausible assumptions. He does not have sufficient evidence for these assumptions (e.g., support information) [8, 9, 11, 12]. A set of such assumptions, ideas, views is for explaining the phenomena, processes and relationships between them in a particular subject domain. And they form a hypothetical concept of an agent, which is understood as a speculative, subjective knowledge.

The conclusions (opinions) based on hypothetical concept (subjective theory) determine a conviction state of a decision maker. He is convinced in his subjective understanding of purposeful state. Conviction stability depends on the frequency and duration of successful results for the goal (O) due to the truth of accepted assumptions, hypotheses, the correctness of the rules of output construction (i.e., a hypothetical concept in general).

If the result of solution based on the subjective perceptions of the decision maker does not match his expectations and creates a state of doubt about the purposeful state, he implements the non-monotonic conviction revision process. This process involves removing a error assumption and/or introducing a new assumption, a correction of output rules. Thus, new convictions are a result of new data gathered from the output system and the monitoring solutions system.

Definition 4. We assume that a fuzzy set $A \subseteq X$ and $B \subseteq X$, where X is a clear set. For each fuzzy set we define α-level sets:

$A_\alpha = \{x \in X : \mu_A(x) \geq \alpha\}$,

$B_\alpha = \{x \in X : \mu_B(x) \geq \alpha\}$,

where $\mu_A(x)$ and $\mu_B(x)$ are functions of belonging. Their values reflect the agent's degree of confidence that an x element belongs A and B. Then a alternative will be more preferable than b alternative, if and only if $x_a > x_b, \forall x_a \in A_\alpha(x), x_b \in B_\alpha(x)$. A is greater than B on α level.

We denote $\underline{\alpha}$ as a minimum value of α when the inequality $x_\alpha > x_b, \forall x_a \in A_\alpha(x), x_b \in B_\alpha(x)$ is true. Then $1-\underline{\alpha}$ is the degree of confidence that a is more preferable than b and indifference when choosing a or b. By analogy, if A_α is contained in B_α ($A_\alpha \subseteq B_\alpha$), then we say that A is contained in B on α level.

If the $\rho=1-\underline{\alpha}$ value increases (or $\underline{\alpha}$ decreases), then the statement that A is greater than B increases (decreases). If $\alpha=0$, any element belonging to a fuzzy set reliably belongs only to this set.

Introduction a degree of conviction when comparing alternatives allows:

– determining the degree of information sufficiency for decision-making. If the value of the degree of confidence is below a certain level, then the decision-making is delayed to gather more information;

– determining the value of collected additional information for CA. It can be zero if the confidence level does not change after receiving. If the value $\rho=1-\alpha$ increased, then the information contributed to the increase of the representation degree of the CA about the choice situation. If $\rho_i(\alpha_i) < \rho_{i-1}(\alpha_{i-1})$, then either there is a misinformation, or the obtained data destroys the representation of the CA about the choice situation and there is a need in new data.

Value $\Delta\rho_i = \rho_i - \rho_{i-1} > 0\ (< 0)$ allows determining the direction of information search. We suppose there are two statements: $\rho \cong X$ is G and $q \cong X$ is F, where F and G are predicates represented as fuzzy sets. Then, if $G \subset F$, $p \Rightarrow q$ (p implies q), this means that the first statement is more informative than the second.

Therefore, changing the awareness of CA leads to changing of his views, and to changing $\mu_A(x)$ and supp A. And they can be used as an awareness measure of CA.

Achieving $G \subset F$ effect requires increasing the number of the properties taken into account when describing. In addition, each additional property should increase the confidence level in distinguishing objects.

Increasing the number of properties can lead to two situations.

1. The new information increases the confidence degree in $G \subset F$. Id est the statement with the new property is more informative than the same statement without it.

2. When comparing two objects with the same number of evaluated properties, and another property is added, but its value for both objects is difficult to distinguish, then the extra information does not increase the degree of confidence in the legibility of objects, but does not reduce it.

The article describes an approach to modeling decision-making by a person based on his subjective submissions about the purposeful choice situation. There is a range of variables to describe subjective understanding the properties of the choice situation. These variables help to receive linguistic estimates and fuzzy numerical estimates. It allows increasing the degree of adequacy for modeling people's behavior in different situations and predicting their behavior for different management methods more precisely.

Referenses

1. Novikov D.A. Modern problems of the theory of organizational systems managing. *Chelovecheskiy faktor v upravlenii* [Human factor in management]. Ed. Abramova N.A., Ginsberg K.S., Novikov D.A. Moscow, KomKniga Publ., 2006, pp. 391–407 (in Russ.).
2. Ackoff R., Emery F. *On purposeful systems: An interdisciplinary analysis of individual and social behavior as a system of purposeful events*. Aldine-Atherton, Chicago, 1972 (Russ. ed.: Rubalskiy G.B., Ushakov I.A. Moscow, Sov. Radio Publ., 1974, 272 p.).
3. Simon H.A. Information processing theory of human problem solving. (Ed.: Estes W.K.). *Handbook of learning and cognitive processes*. Hillsdale, N.J., Erlbaum Publ., 1978, vol. 5.
4. Tversky A., Kahneman D. The framing of decisions and the rationality of choice. *Science, New Series*. 1981, vol. 211, no. 4481, pp. 453–458 (33, 34).
5. Yarushkina N.G. *Osnovy teorii nechyotkikh i gibridnykh sistem* [The basics of fuzzy and hybrid systems theory]. Moscow, Finansy i statistika Publ., 2004 (in Russ.).
6. Burkov V.N., Vinogradov G.P., Kuznetsov V.N., Palyukh B.V., Semenov N.A. Intelligent active systems. *Trudy 12 nats. konf. po iskusstvennomu intellektu s mezhd. uchastiem* [Proc. of the 12 national conf. on Artificial Intelligence with int. engagement]. Moscow, Fizmatlit Publ., 2010, vol. 3, pp. 35–43 (in Russ.).
7. Vinogradov G.P. Simulation of the representations forming by an intelligent agent in the purposeful choice state. *Problemy informatiki* [Problems of Computer Science]. 2010, no. 3, pp. 66–72 (in Russ.).
8. Vinogradov G.P., Kuznetsov V.N., Semenov N.A. A model of the agent's representations and beliefs about the purposeful choice state. *Trudy Kongressa po intellektualnym sistemam i informatsionnym tekhnologiyam "AIS-IT'10"* [Proc. of Congress on Intelligent Systems and Information Technology "AIS-IT'10"]. Moscow, Fizmatlit Publ., 2010, vol. 1, pp. 119–123 (in Russ.).
9. Novikov D.A. *Matematicheskie modeli formirovaniya i funktsionirovaniya komand* [Mathematical models of commands' formation and functioning]. Moscow, Fizmatlit Publ., 2008 (in Russ.).
10. Vinogradov G.P., Kuznetsov V.N. Simulation of the agent's behavior considering subjective views in the purposeful choice situation. *Iskusstvenny intellekt i prinyatie resheniy* [Artificial intelligence and decision-making]. 2011, no. 3, pp. 58–72 (in Russ.).
11. Avtonomov V.S. *Model cheloveka v ekonomicheskoy nauke* [Human model in economical science]. St. Petersburg, Ekonomicheskaya shkola Publ., 1998, 72 p. (in Russ.)
12. Vagin V.N., Pospelov D.A., eds. *Dostoverny i pravdopodobny vyvod v intellektualnykh sistemakh* [Reliable and realistic output in intelligent systems]. 2nd ed., Moscow, Fizmatlit Publ., 2008, 712 p. (in Russ.).