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Using Game Theory and Fuzzy Logic to Determine the Dominant Motivation Cognitive Agent

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Abstract

People's behavior is motivated. When simulating this behavior in artificial systems (animat, robots, software agents) plays an important role the possibility of formalizing the dominant motivation as an established and weighted correspondences between semantically understandable by stimuli in the external environment and needs (internal environment) of the agent. The purpose of the software implementation of such systems it is desirable that the motivation was formalized and as simple as possible methods. In this regard, the article discusses known methods of selection and decision-making, interpreted to the assessment of the dominant motivation. These methods differ from each other take into account the information in the interaction of the external environment and the agent, which are considered as players of some games. So in the absence of common knowledge about preferences to determine the dominant motivation uses a combination of forward and reverse output methods that are known in fuzzy logic. Next, the paper deals with different cases of the possession of general knowledge from the point of view of the game approach. A matrix game is private, but there is a case of the players ' relationship. In this case, we mean the situation when it is impossible to accurately determine the winnings. Therefore, they are defined as fuzzy numbers, defined on intervals. Finally, the bimatrix game is proposed for the case of unknown relationship between stimuli in the external environment and the needs of the agent, and which is synthesized based on the known linguistic values preferences strategies of the players.

1. Introduction

Motivation is considered one of the properties of adaptive agents with different architectures. However, research related to the modeling of processes of formation of adaptive behavior of agents that have specific needs, yet small [5, 11] or limited to the analysis of natural needs [14]. Currently, the motivation is used in two senses [8]:

- as a psychological process, causing the beginning and direction of purposeful action;
- the willingness of the agent to specific actions to achieve the objectives of the activity under the influence of certain external and internal factors that influence its activity.

There is whiter than a dozen theories of motivation, which is divided into two main areas: content and process [13]. Content theories of motivation based on the identification of the internal motives (needs) that cause people to act in certain ways. Process theories of motivation is associated with human reaction motivating factors, i.e., that causes him to direct efforts to achieve different objectives. The complexity of the psychological process of formalization of the person associated with motivation requires the use of certain limitations in modeling the behavior of the agent. In particular, it cannot address all possible needs of the agent, but only those that appear within a particular organizational and/or social system. In this case, refers to the possible human needs peculiar to it as in the economic sphere and in social life. The second limitation is due to the indirect light of the links between the needs and motivations through stimulating factors, conscious agent based on the experience of behavioral experience.

Given these constraints, consider the problem of determining the dominant motivation in the following formulation. At the current time t the agent has n needs $X=\{x_1, ..., x_n\}$, which in varying degrees of relevance to him. The implementation depends on the needs of environmental stimuli $Y=\{y_1, ..., y_m\}$. Communication between the needs and incentives determined by the ratio $R:X\times Y$, which defines the degree of compliance requirements and the implementation of the stimulus or outcome needs x_i using stimulus y_i, $i=1, ..., n$, $j=1, ..., m$. In that case, if the agent only perceives and evaluates environmental stimuli, his task is to select the needs (alternative), which corresponds to the stimulus is most conducive to the implementation needs. Given these constraints, consider the problem of determining the dominant motivation in the following formulation. At the current time t the agent has n needs $X=\{x_1, ..., x_n\}$, which in varying degrees of relevance to him. The implementation depends on the needs of environmental stimuli $Y=\{y_1, ..., y_m\}$. Communication between the needs and incentives determined by the ratio $R:X\times Y$, which defines the degree of compliance requirements and the implementation of the stimulus or outcome needs x_i using stimulus y_i, $i=1, ..., n, j=1, ..., m$. In that case, if the agent only perceives and evaluates environmental stimuli, his task is to select the needs (alternative), which corresponds to the stimulus is most conducive to the implementation needs. Due to the fact that in a certain time interval hierarchy built agent needs a system preference $\alpha(X)$, the problem reduces to two criterial optional alternative set of X. In other words, alternative x_i is evaluated based on its preference agent (criterion $\alpha(X)$) and the degree of compliance of the stimulus y_j needs x_i (criterion R). In that case, if the external environment is not neutral, i.e. interested in promoting certain stimuli, it can determine the preferences of a variety of stimuli $\beta(Y)$. As the external environment may join other agents or at a higher level of management (director). Thus, the selection of preferences agent becomes dependent on the preferences of the environment, and the choice of environmental stimuli dependent on the preferences of the agent. This behavior of the parties correspond to modern concepts of management, where the choice of the agent is determined, on the one hand, within the organizational system (slave, job descriptions, employment contracts), and on the other hand, their own interests (health care, social status, personal conflicts and experiences). Similarly, the choice is limited to the head, on the one hand, the need to follow the interests of the organization, on the other hand, the need to take account of current interests subordinate. Thus, we have many alternatives agent $\{x_i, y_j\}_{X\times Y}$, which can be evaluated based on the criteria $\alpha(X)$, $\beta(Y)$ and the known values of R. In R, α and β, the problem of determining the dominant motivational stimulus $y_j{:}r_{i,j}\rightarrow max$, $\alpha\geq\lambda$ and $\beta\geq\lambda$, where λ - a threshold value can be reduced to the problem of multicriteria optimization. The problem is that, in real situations, the agent may be unknown to the preferences of the environment, and conversely, the external environment is unknown preference agent. This fact does not allow solving the problem of multicriteria evaluation of alternatives. Therefore, it is more natural to consider the game stating the problem, focusing on the situation of conflict between the agent and the external environment with overlapping interests of the players. Thus, the player can be used compromise strategies of behavior characterized by a balance of interests of the conflicting parties at the secondary level. In particular, the argument in terms of the agent may be the following. If x_{max} - the most preferred requirement, which can be realized only under conditions of risk, due to the insignificance of the incentives and the absence of complete information on the priorities of the other organizational systems, it should be an acceptable alternative for solving the problem of $(\alpha(x_{max})\text{-}\alpha_\lambda(x_i))\rightarrow min$ under the constraints imposed on the values of $\beta(Y)$ and R. Similarly, the other party is looking for a solution of problem $(\beta(y_{max})\text{-}\beta_\lambda(y_j))\rightarrow min$ based on estimates $\alpha(X)$ and R. In this case, the trade-offs (x^*, y^*) is characterized by performing the following conditions: $x^*\in[x_\lambda, x_{max}]$, $y^*\in[y_\lambda, y_{max}]$, where x_λ and y_λ - an alternative to the preferences of the players $\alpha\geq\lambda$ and $\beta\geq\lambda$.

In addition, incompleteness of knowledge of players in relation to ends and ambiguousness in determination of preferences and relation of R require formulation of the problem under uncertainty. In this regard, consider formal methods to assess the motivational incentives to meet the needs of intelligent agent based on the use of fuzzy logic and game theory.

2. The Compositional Rule of Inference

Let the agent is stored in the memory of a fuzzy matrix $C_{i,j}=P_i\times D_j$, where P_i - needs an agent; D_j - possible motivational incentives. At the intersection of rows and columns of the matrix coefficients bear $c_{i,j}$, which determine the degree of compliance needs motivation. Then, if the current time, an agent identified preferences implementation needs α_i, $i=1, 2, ..., n$, i.e. $P=\{\alpha_1/p_1, ..., \alpha_n/p_n\}$, then to determine the dominant stimulus at time t, is sufficient to solve the equation $P\circ C_{i,j}=D$, where "$\circ$" - sign operation maxmin composition as $D=\{\beta_1/d_m, ..., \beta_n/d_m\}$. In this case, we assume that p_i needs with a degree equal to $max\{\alpha_i/p_i\}$ will match the dominant stimulus d_j with degree equal to $max\{\beta_i/p_j\}$.

Considered a mechanism based on the application of plausible reasoning schema types:

$$\frac{\begin{array}{l} p_i \rightarrow d_j \\ p_i^* \end{array}}{\quad d_j^*}$$

This circuit operates at a fixed matrix $C_{i,j}$ and current developments agent preferences regarding his needs. Changing the coefficients $C_{i,j}$ is determined by factors that indirectly affect compliance motivation needs.

Strengthen the schemes considered the possibility of using non-monotonic reasoning with exceptions like: if <premise> then <decision> unless <exception> or if P then D unless E, where E - the exception [10]. This scheme assumes that once the premise is established, a decision can be made, if at the same time not found exception. Since exceptions are very rare, in most cases, the decision follows the premise. In this case the only solution D or E exception may be true, that is, between the decision and exception exists ratio exclusive-OR. So the ratio defined by using the "if not" between D and E is given by:

$$(D \cap \neg E) \cup (E \cap \neg D),$$

where $\neg, \cup, \cap$ - the fuzzy operators addition, S-conorm and T-norm, respectively. In [10] introduced in relation coefficient γ, which shows the weight (importance) are exceptions. In this case, the modified ratio can be written as follows:

$$(D \cap \gamma \neg E) \cup (\gamma E \cap \neg D),$$

moreover, when γ=0 is not considered an exception.

Thus, the use of exceptions can store in memory a fixed matrix $C_{i,j}$, and in the process of learning to change the set of exceptions and their importance coefficients.

In considering approaches to determining the dominant motivation is assumed that all the arguments are done by the agent based on its own model and analysis of the facts resulting from cognitive processes [11]. In organizational system, the source of the facts may be another agent, such as the head, which may have its own view of the facts regarding preferences as motivational incentives, and their relationship to the needs of the agent. If the agent has no idea about preferences regarding motivational incentives leader, he can match them to your preference needs.

Let $X=\{x_1, \ldots, x_n\}$ and $Y=\{y_1, \ldots, y_m\}$ - agent needs and environmental stimuli, respectively. Authors call such a dominant motivational incentive incentive $y_j \in Y, j=1, 2, \ldots, m$, which is most relevant to the needs of some $x_i \in X, i=1, 2, \ldots, n$. Is assumed to be the ratio of $R{:}X\times Y\to[0, 1]$, which determines the degree of compliance requirements and incentives. In most of the organizational systems of incentives, in the form of objectives and tasks defined higher levels of government, which is interested in the implementation of concrete incentives. On the other hand, needs agents are not rigidly fixed and can vary. Agent relationship to the needs and the manager (environment) to stimuli at a time determined by means of preference functions $\alpha{:}X\to[0, 1]$ and $\beta{:}Y\to[0, 1]$. Thus, with the known values of R, α and β, the problem arises of determining the dominant incentive motivational $y_j{:}r_{i,j}\to max$, $\alpha\geq\lambda$ и $\beta\geq\lambda$, where λ - a certain threshold value.

Consider the solution of this problem from the point of view of the agent and the manager. If known, for both, the relation R, and the resulting sets of X and Y, the agent at time t, know your own preference α, relative to X, but the preference is not known leader β, relative to Y. Similarly, the head of the known preference for a given stimulus Y relation R, but need not know the current agent. Under these conditions, each of them can estimate the unknown preferences based on the forward and reverse composite output used in the fuzzy logic [12]. Thus, the agent by solving the equation $\alpha \circ R=\beta^*$, is assessed preferences manager. In turn, the head, solving the equation $\alpha^* \circ R=\beta$, the unknown α^*, is assessed agent preferences. Available preferences and their assessment reduce the matrix M (table I):

Table I. *Matrix preferences.*

		y_1		…	y_m	
	x_1	β_1	β^*	…	β_m	β_m^*
		α_1	α^*		α_1	α_1^*
M=	…	…		…	…	
	x_n	β_1	β^*	…	β_m	β_m^*
		α_n	α_n^*		α_n	α_n^*

Let the agent and supervisor informs the other side of the resulting estimates. Then, each of them can choose the most appropriate strategy of behavior as follows:

$$\begin{aligned} \alpha^{\wedge} / X &= \max_i \min_j(\alpha, \alpha^*) \\ \beta^{\wedge} / Y &= \max_j \min_i(\beta, \beta^*) \end{aligned} \quad (1)$$

The matrix M can be interpreted as a payoff matrix bimatrix game, at the intersection of rows and columns of which, instead of winning players, bear pair preference ratings of strategies $(\alpha, \alpha^*)/x_i$ and $(\beta, \beta^*)/y_j$, where α/x_i and β/y_j - preferences strategies of the first and second player, and α^*/x_i and β^*/y_j - wait a second, and the first player on the choice of strategies for the opposite side. Define the payoff function of each player as $min_j(\alpha, \alpha^*)$ and $min_i(\beta, \beta^*)$. Authors show that the pair of strategies $(\alpha^\wedge/x_i, \beta^\wedge/y_j)$ is a Nash equilibrium. Nash equilibrium in pure strategies - is a pair of strategies $(x_i^\wedge, y_j^\wedge)$, that for each player the following condition: $r_{i,j}(x_i, y_j^\wedge)\leq r_{i,j}(x_i^\wedge, y_j^\wedge)\geq r_{i,j}(x_i^\wedge, y_j))$.

Suppose that some of the players, such as the second player has deviated from the equilibrium strategy and chose a more preferred strategy y_j with $\beta(y_j)\geq\beta(y_j^\wedge)$. According to (1), we have $\beta^*(y_j)<\beta(y_j)\&\beta^*(y_j)<\beta(y_j^\wedge)\&\beta^*(y_j)<\beta^*(y_j^\wedge)$. In this case, $min_i(\beta(y_j), \beta^*(y_j))<min_i(\beta(y_j^\wedge), \beta^*(y_j\underline{\wedge}))$, ie when changing its strategy the second player gets smaller winnings. On the other hand, in accordance with the operation maxmin compositions value $\beta^*(y_j)$ is the highest amongst the values of a set $min(\alpha(x_1), r_{1,j}(x_1, y_j)), \ldots, min(\alpha(x_n), r_{n,j}(x_n, y_j))$.

Let $\beta^*(y_j)=min(\alpha(x_i), r_{i,j})$. Then, a $\beta^*(y_j)=\alpha(x_i)$, or $\beta^*(y_j)=r_{i,j}$. In the first case, $r_{i,j}>\alpha(x_i)$. Here, $r_{i,j<}r_{i,j}(x_i^\wedge, y_j^\wedge)$. If $r_{i,j}\geq r_{i,j}(x_i^\wedge, y_j^\wedge)$, then (x_i, y_j) the situation is an equilibrium solution. In the latter case, it is obvious that $r_{i,j}<r_{i,j}(x_i^\wedge, y_j^\wedge)$.

Similarly, consider the option to change the strategy of the first player.

Informally, the deviation from the equilibrium strategy is the creation of a situation of conflict between the need for agent and motivational incentive leader. Resolution of the conflict is possible only dictatorial manner, meaning coercion on the part of the head, to perform uninteresting for the agent work, or refusal (sabotage) agent from job.

Note that the equilibrium solution is also defined by the following conditions: $\alpha \geq \lambda$ and $\beta \geq \lambda$. Failure to follow these conditions leads to the rejection of the equilibrium solutions of a party or by both players, and is associated with a low estimate of the equilibrium profile preferences.

3. Fuzzy Matrix Games

Fuzzy Matrix two-person game defined payoff matrix $C_{i,j}$. In the classical matrix game payoff matrix coefficients determine win/lose players when they use certain strategies. In our case, the win/loss are fuzzy terms of linguistic variables "win rate"/"The level of loss" when implementing agent specific need and use head a certain motivational stimulus. Each fuzzy term is a fuzzy numbers defined on the universal set of wins/losses. As in the classical setting, the matrix element $c_{i,j}$ is interpreted as the value of winning for one player, and as the amount of loss, to another player, and these values have opposite signs (Figure 1).

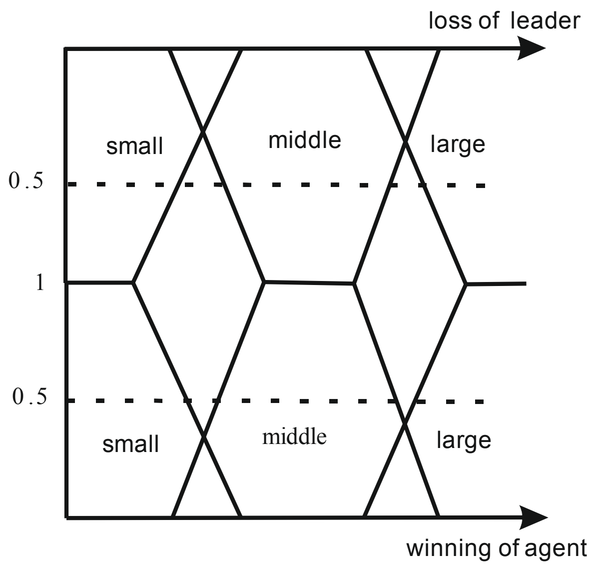

Figure 1. *Setting the linguistic values of the payoff matrix.*

In the classical formulation implicitly assumes that preferences strategies indistinguishable and equal to 1. Thus, to determine the price of the game in pure strategies used maximin composition regarding the 2nd player and minmin composition relative to the decisions of the first player. In other words, the preferences of the players are defined as p_i and d_j, and the top price and the lower price is determined as follows:

$$\_{>} = min\,(PoC_{i,j}) = min\,(max\,\min_j\,(p_i, c_{i,j}));$$

$$\varpi = max(D \bullet C_{i,j}) = max(min\,\min_j(d_j, c_{i,j}))$$

When searching for the solution of the game in mixed strategies under $c_{i,j}$ refers to the possibility of the corresponding estimate of win/loss defined linguistically. Decision of the game in the formalization of linguistic terms of the triangular fuzzy numbers and LR-type type can be found, for example, in [1-3].

Consider setting the fuzzy matrix game where players are specific strategies, and win/loss are uncertain. This formulation assumes that the players are known for their strategy, the strategy of the first player are his needs and strategies of the second player - the job offered to the first player to run. If the first player A allocates some need i, and performs a certain task j, then his payoff is of the $c_{i,j}$, which is given by fuzzy numbers. The second player B, offering a job j, the implementation of the first player needs i, receives a payoff $c_{i,j}$, but with the opposite sign. This game takes place when the first player uses the strategy to maximize the gain, and the second player uses the strategy to minimize loss.

Using fuzzy matrix game as a model of behavior of elements of the organizational system is justified by the following considerations. The future behavior of the first player is determined by the dominant, at the moment, need. Targets to be met by the second player, act for him as a motivational incentives. For the second player, it is important to perform certain tasks. In such a situation, the performance of specific tasks in implementing the different needs, perhaps with different quality. As a result, if the first player satisfying a certain i-th need, performs the j-th job, he receives a payment in the amount of $c_{i,j}$. The second player loses the same amount.

Fuzzy number c is defined as a monotonic increasing function $c{:}R \to [0, 1]$ on the real axis R, provided that there exist real numbers α_0, $\alpha_1 \in R$, $\alpha_1 > \alpha_0$, such that [9]:

$$\alpha(z) = \begin{cases} 1, & если\ z \leq \alpha_0 \\ 0, & если\ z > \alpha_1 \end{cases}.$$

System G (X, Y, C), where X and Y - non-empty sets, C: $X \times Y \to \tilde{R}$, where $\tilde{R}$ - the set of fuzzy numbers, fuzzy game called two-person zero-sum. Elements $x \in X$, $y \in Y$ are called strategies of the players A and B, respectively.

If player A gets the win $c(x, y)$, then player B has a loss $-c(x, y)$.

Fuzzy payoff matrix is defined as follows [6]:

$$c_{i,j}(z) = \begin{cases} 1, & если\ z \leq \alpha_i \\ \dfrac{\alpha_i}{z} & если\ \alpha_i < z \leq n\alpha_i \\ 0, & если\ x > n\alpha_i \end{cases},$$

where $n>1$, $i=1, 2, ..., m$, $j=1, 2, ..., n$.

Consider a game with a rectangular payment matrix $C=(c_{i,j})$, where $c_{i,j}$ is a fuzzy number. Let $x=(\xi_1, \xi_2, \ldots, \xi_m) \in X$ is a mixed strategy of the first player and satises $\sum_{i=1}^{m} \xi_i = 1$. Similarly, let $y=(\eta_1, \eta_2, \ldots, \eta_n) \in Y$ is the mixed strategy of the second player, and satisfies the condition $\sum_{j=1}^{n} \eta_j = 1$. Mixed strategies chosen by players independently. Then, the expectation of winning $C(x, y)$ corresponds to a fuzzy number

$$C(x,y)=\sum_{j=1}^{n}\sum_{i}^{m}c_{i,j}\xi_i\eta_j .$$

It is assumed that the players make careful decisions, which are reduced to the choice of such strategies, which lead to the best of the worst results. So, the first player chooses the strategy that maximizes his minimum winnings. This choice is motivated by the principle of maximin. The second player chooses the strategy that minimizes the maximum loss and its choice is determined by the principle of minimax.

Point (x^*, y^*) in the game $\Gamma(C)$ is called a solution of the game or a saddle point, and the number $v=C(x^*, y^*)$ - the value of the game, if $C(x, y^*)\leq C(x^*, y^*)\leq C(x^*, y)$ for all $x\in X, y\in Y$. Strategy x^* and y^* is called optimal strategies for the 1st and 2nd of players, respectively.

In [9] it is proved that if $C=(c_{i,j})$ - rectangular payoff matrix of fuzzy numbers game $\Gamma(C)$, then this game has a saddle point in mixed strategies of players. A saddle point is defined by the upper and lower price of the game: $\vee_{x\in X}\wedge_{y\in Y} C(x, y) = \wedge_{y\in Y}\vee_{x\in X} C(x, y)$,

where $C(x,y)=\sum_{j=1}^{n}\sum_{i}^{m}c_{i,j}\xi_i\eta_j$.

The procedure determines the choice of optimal mixed strategies for the game $\Gamma(C)$ with the payoff matrix $C=(c_{i,j})$ and known for each player probability to use pure strategies, reduced to the following steps:

1. Subject mixed strategies $x\in X, y\in Y$ matrix and the initial payment $(c_{i,j}(z))$ is converted into a matrix $(c_{i,j}(z)\xi_i\eta_j)$.
2. Determine the expectation of winning $C(x,y)=\sum_{j=1}^{n}\sum_{i}^{m}c_{i,j}(z)\xi_i\eta_j$, based on fuzzy arithmetic operations.
3. The optimum mixed strategy of the first and second players: $\vee_{x\in X}\wedge_{y\in Y} C(x, y)$, $\wedge_{y\in Y}\vee_{x\in X} C(x, y)$.

4. Fuzzy Bimatrix Games

Bimatrix games give more opportunities to analyze the behavior of players due to the inclusion of heuristic knowledge about the behavior of a single agent of another agent. In the previous section it was assumed that the fuzzy payoff matrix is given. Consider the approach to the construction of fuzzy payoff matrix agents under certain linguistic preferences strategies defined functions preferences and rules for evaluating any pair of strategies [4], as an application to the determination of the dominant motivation intelligent agent. As before, we assume that the first player's strategies are the needs and strategies of the second player - motivational incentives in the form of production targets. Each player can set the payments in the form of linguistic fuzzy preference matrix for any pair of strategies. Resolution process of the game consists of three steps: fuzzification, fuzzy inference and defuzzification. The result is a superposition stages matrices preferences of players in the form of fuzzy bimatrix game.

Let $X=(X_1, X_2, \ldots, X_m)$ and $Y=(Y_1, Y_2, \ldots, Y_n)$ - strategies agent (1st player) and the head (2nd player), reflecting the needs of the first and second stimulus, respectively . Each of the players can express a preference for using strategies by setting functions: $L(X)$ and $L(Y)$. These functions are linguistic variables defined preferences possible strategies of the players. For simplicity, we assume that the functions are determined by three fuzzy variables, ie, $L(X)$:$L(X_i)=\{T_i^1, T_i^2, \ldots, T_i^3\}$, $L(Y)$:$L(Y_j)=\{T_j^1, T_j^2, \ldots, T_j^3\}$. Here $T_i^1, T_i^2, \ldots, T_i^3$ and $T_j^1, T_j^2, \ldots, T_j^3$ - fuzzy variables with membership functions $\mu_X(L(X_i))/L(X_i)=\{\mu_X(T_i)/T_i\}$ and $\mu_Y(L(Y_j))/L(Y_j)=\{\mu_Y(T_j)/T_j\}$, respectively. Each term is defined fuzzy membership function trapezoidal or triangular shape, symmetrically distributed on the universe of players' strategies.

Fuzzification players' strategy defines the mapping $\mu_X(L(X_i))/L(X_i)$:$X_i\rightarrow[0, 1]$ and $\mu_Y(L(Y_j))/L(Y_j)$:$Y_j\rightarrow[0, 1]$. Display data show that each $x\in X$ and each $y\in Y$ corresponds to the number of the interval [0, 1], which indicates the extent to which x has the attribute T_i, and y is the attribute T_j. This means that they must be given the scale of X_i and Y_j, which directly or indirectly measure the needs and incentives. For example, physiologists strategic need for food, water, clothing, etc. can be expressed in monetary equivalent. The need for self-realization through the complexity of the job. The need for health - through values of physiological parameters.

Let the players are known linguistic preferences value strategies of their opponents. Authors define, for each pair of strategies (X_i, Y_j) and (Y_j, X_i), linguistic variables $U(L(X), L(Y))$ and $V(L(Y), L(X))$, determine the relative preferences of players pairs strategies term-set $<U_1, U_2, \ldots, U_r>$ and $<V_1, V_2, \ldots, V_r>$. For the convenience of using linguistic and numerical description of membership functions U_k, V_k, k=1. 2, ..., r, i.e. $U_k^{i,j}\in\{0, 0.2, 0.4, 0.6, 0.8\}$, $V_k^{j,i}\in\{0, 0.2, 0.4, 0.6, 0.8\}$ [6]. Here, linguistic-numeric descriptions are defined on a normed universe pairs strategies and considered the center of the corresponding membership functions. Then, the reaction of players expressed assessment couple of strategies about the intentions of the opposing party may be displayed matrices preferences. For example, table II shows the preferences of the 1st player expressed by fuzzy terms $U_k^{i,j}$.

Table II. *Matrix fuzzy preferences pairs strategies 1st player.*

			Y_1		…		Y_n	
		T_1^1	T_1^2	T_1^3	…	T_1^1	T_1^2	T_1^3
	T_1^1	$U_k^{1,1}$	$U_k^{1,1}$	$U_k^{1,1}$	…	$U_k^{1,n}$	$U_k^{1,n}$	$U_k^{1,n}$
X_1	T_1^2	$U_k^{1,1}$	$U_k^{1,1}$	$U_k^{1,1}$	…	$U_k^{1,n}$	$U_k^{1,n}$	$U_k^{1,n}$
	T_1^3	$U_k^{1,1}$	$U_k^{1,1}$	$U_k^{1,1}$	…	$U_k^{1,n}$	$U_k^{1,n}$	$U_k^{1,n}$
…	…	…	…	…	…	…	…	…
	T_1^1	$U_k^{m,1}$	$U_k^{m,1}$	$U_k^{m,1}$	…	$U_k^{m,n}$	$U_k^{m,n}$	$U_k^{m,n}$
X_m	T_1^2	$U_k^{m,1}$	$U_k^{m,1}$	$U_k^{m,1}$	…	$U_k^{m,n}$	$U_k^{m,n}$	$U_k^{m,n}$
	T_1^3	$U_k^{m,1}$	$U_k^{m,1}$	$U_k^{m,1}$	…	$U_k^{m,n}$	$U_k^{m,n}$	$U_k^{m,n}$

Similarly, construct a matrix of fuzzy preference 2nd player with fuzzy terms $V_k^{i,j}$.

Let $Z=X\times Y$ is the space of solutions of the players, and

$J=L(X_i)\times L(Y_j)$ be the set of fuzzy subsets associated with the preferences of the players, their strategies. Then, the decision of each player is as a mapping $g:Z\rightarrow J$, and the rules to calculate the preferences of the players are defined as follows [4]:

Rule 1. If $L(X_i)=T_i^l$ and $L(Y_j)=T_j^h$, then $J_1^{l,h}\{U_1, U_2, ..., U_r\}$.

Rule 2. If $L(X_i)=T_i^l$ and $L(Y_j)=T_j^h$, then $J_2^{l,h}$ $\{V_1, V_2, ..., V_r\}$.

To calculate the membership functions making players use the formula:

$$\mu_1(X^l, Y^h, J_1^{l,h})=\min(\mu_X(T_i^l), \mu_Y(T_j^h))\mu(U_k^{l,h})==\mu_{X,Y}(T_i^l, T_j^h)\mu(U_k^{l,h});$$

$$\mu_2 (X^l, Y^h, J_2^{l,h})=\min(\mu_X(T_i^l), \mu_Y(T_j^h))\mu(V_k^{l,h})==\mu_{X,Y}(T_i^l, T_j^h)\mu(V_k^{l,h}).$$

To apply the classical method of defuzzification center of gravity, allowing to obtain a cardinal measure of the preferences of the players [7]:

$$J_1^{l,h} = \sum_{i,j,k} \mu_{X,Y}(T_i^l, T_j^h)\mu(U_k^{l,h}) / \sum_{i,j,k} \mu(U_k^{l,h}),$$
$$\sum_{i,j,k} \mu(U_k^{l,h}) \neq 0$$

$$J_2^{l,h} = \sum_{i,j,k} \mu_{X,Y}(T_i^l, T_j^h)\mu(V_k^{l,h}) / \sum_{i,j,k} \mu(V_k^{l,h}),$$
$$\sum_{i,j,k} \mu(V_k^{l,h}) \neq 0$$

The result is a fuzzy preference J_1 and J_2 for each pair of strategies (X_i, Y_j) and (Y_j, X_i), which is conveniently represented as a matrix (table III, IV).

Table III. *Fuzzy preference matrix of the first player.*

		Y_1	…	Y_n
	X_1	$J_1^{1,1}$	…	$J_1^{1,n}$
$J_1=$	…	…	…	…
	X_m	$J_1^{m,1}$	…	$J_1^{m,n}$

Table IV. *Fuzzy preference matrix of the second player.*

		Y_1	…	Y_n
	X_1	$J_2^{1,1}$	…	$J_2^{1,n}$
$J_2=$	…	…	…	…
	X_m	$J_2^{m,1}$	…	$J_2^{m,n}$

The superposition of these matrices allows us to go to the fuzzy bimatrix game preferences of players represented by the matrix (table V).

Table V. *Fuzzy bimatrix game in the form of a matrix of preferences pairs strategies of the players.*

	Y_1	…	Y_n
X_1	$J_2^{1,1}$ $J_1^{1,1}$	…	$J_2^{1,n}$ $J_1^{1,n}$
…	…	….	…
X_m	$J_2^{m,1}$ $J_1^{m,1}$		$J_2^{m,n}=$ $J_1^{m,n}$

In [4] the possibility of finding a Nash equilibrium in pure strategies for this game, which satisfies the following conditions:

$$J_1(X_i^*, Y_j^*)\geq J_1(X, Y_j^*), X_i\in X;$$

$$J_2(X_i^*, Y_j^*)\geq J_2(X_i^*, Y), Y_i\in Y.$$

5. Discussion and Application

Using the agent needs and allocation of its dominant motivation in subsequent decisions and behavior strategies have raised doubts make optimal decisions only on the basis of the principle of "rationality" as an effective maximization of someone else's expected benefits.

5.1. Prisoner's Dilemma

In this problem, the application of the principle of "rationality" of each player is to that betrayal is strictly dominates cooperation, so the only possible equilibrium - a betrayal of both parties. Reformulate the problem as follows. Let strategies of one player are his needs and strategies of other players - cooperation or betrayal of the first player. Thus, the first player needs may be a need for friendship and the need for personal safety. If the game is played once, at the current time, for each player are unknown preference selection strategies opposite side. Moreover, if the need for the first player in the friendship strictly need dominates personal safety, it selects its first strategy, regardless of the choice of the second player. Similarly, if the need for personal security is strictly dominated by the need for friendship, the choice of the first player to be made in favor of the second stratum-gies. However, for the first player indifferent choice of the second player, ie he can express his attitude to the strategies of the second player in the form of preference. For repeated game, to the dominant system needs change and preferences of the other strategies. For this problem, the need is a function of the behavior of the second player, and the choice of specific needs not directly related to the gain in the form of utility. Thus, according to Taoist proverb, changing needs can be determined by the following rules:

- Good for good - gives good;
- Evil for evil - gives good;
- Evil for good - gives evil;
- Good for evil - gives evil.

In the proposed formulation of the problem of choosing each player's strategy will be to the unknown preferences and system rules the opposite side. The above methods of determining the dominant motivation agent just allow a choice with the priorities of the other side (reflection) that allows you to come to equilibrium choice of the parties, and not to balance the benefits, often leading to limited choice.

5.2. The Interaction of Agents in Linear and Matrix Management Structures

Authors will consider a problem of distribution of projects in head-performer system. Let n and m – strategy of the head

(H) and the performer (P) as which projects and requirements act. Authors will consider that each strategy H is characterized by a set of the parameters known P on the basis of which it can correlate the project of some requirement. In game statement the solution of a task is consolidated to a choice of such strategy which, in a sense, suit both parties. Unlike "the prisoner's dilemma" of $n \neq m$ and n, $m \geq 2$. On the one hand these conditions complicate a choice of strategy, on the other hand, provide a big freedom of choice and flexibility of interaction.

In case of use of a composite method the relation between strategy is expressed by the indistinct matrix defining degree of compliance of the project of some requirement. Each of players of R and I, seeks to carry out a choice of the strategy not only on the basis of the preferences, but also considering preferences of other party. Such choice more corresponds to modern ideas of features of relationship between the head and the subordinate in an enterprise management system. Within a composite method each of players builds model of preferences of the strategy of the opposite side corresponding to own preferences and reports it other party. Further each of the parties carries out the choice on the basis of both own preferences, and "wishes" of the opposite side.

Use of such approach is caused by the following reasonings. The player H can apply a dictatorial way of purpose of the project, but risks to face non-performance of a task because of, for example, feeling sick of the employee. The player P, pursuing only the interests, risks to lose work, an award, etc.

In case of fuzzy bimatrix game neither the matrix of payments, nor a matrix of compliances isn't set. Each player has linguistic functions of preferences on the strategy and rules of an assessment of preferences of couples of strategy (personal and others'). The analysis of various rules allows players to construct matrixes of preferences of couples of pure strategy, and for the decision to use Nash's balance.

5.3. Problem of the Bargaining

Consider the formulation of this problem in a system of interacting "buyer-seller". The seller has a range of goods (strategy), the prices of which he can adjust to a certain extent. Buyer has a set of needs (strategy) in goods, and the desire to reduce the price of goods. In this case, the problem can be reduced to the fuzzy matrix game, which is described by the payoff matrix with fuzzy numbers, which determine the price of goods.

5.4. Distance Education

In distance education the priority given to the use of adaptive learning systems aimed at changing the form and content of educational material, depending on the needs of the learner. The system of "learning-electronic textbook" to select strategies can be applied as a composite output and fuzzy bimatrix game. In both cases the strategies are taken into account preferences opposite side. Preferences electronic textbook are based on a typical student model. Learner strategies are determined depending on the potential learning goals and preferences are characterized by individual learning model.

6. Conclusion

The use of fuzzy logic and game theory allows to formalize the problem of determining the dominant motivation intelligent agent in multi-agent systems.

The article discusses approaches for solving this problem in different starting situations. Thus, it is proposed to use the compositional rule of inference in the case of exchange of information regarding suspected players' preferences opposite side. For the particular case of interaction of players equilibrium solution is in a class of fuzzy matrix games. And finally, in the absence of the possibility of determining payments in the form of utility, constructed matrix preferences pairs strategies of the players on the basis of job fuzzy preferences pure strategies and rules of inference. In the latter case, the superposition of fuzzy matrices preferences allows us to go to the fuzzy bimatrix game and use the well-known approaches to the search for balance-solutions.

Further development of the proposed approaches to the application associated with the analysis of the dominant motivation is seen in the use of the problem of bargaining in the fuzzy setting, as well as in finding solutions for the case when the full set of strategies opposite side is unknown.

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