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## AGENT-BASED MODELLING OF EMOTIONS IN LEARNING SYSTEMS

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**Abstract** – An approach to construct models for the functioning of multiagent systems that take into account the factors of subjectivity, uncertainty and blurring, as well as human behavior in solving specific problems in conditions when goals are known and they are formalized is considered.

**Keywords** – *models of emotions, simulation, multi-agent systems, learning systems.*

By "subjective" we mean such a judgment about an object that is expressed by the subject and differs from reality, thereby emphasizing the individuality of the subject's judgment. The subject is usually a person who knows the laws of the objective world and transforms it on this basis. Recently, according to the wide use of the concept of "agent modeling" [4] and some possibilities of modeling mental types of nervous activity and the mechanism of emotions, the concept of "subject" is increasingly coming from the positions of artificial intelligence, from which it follows that any structure, capable of perceiving the information about the object, classifying the situations in it, predicting its behavior and making decisions that ensure resultativity, when the object is impacted with respect to the achievement of the goal, can be considered an entity. Thus, the concept of "subject" in the information view becomes applicable not only to the person, but also to the software intellectual agent.

Each agent can have its own individuality, because systems with complex structure always have some degree of difference. In addition, the decisions made by the subject in difficult situations tend to differ from the optimal ones,

since for the subject the object is always only partially cognized, partially observed and partially controlled. However, the degree of subjectivity can be different, and only if it is significant from the point of view of the information process, it is advisable to talk about subjectivity.

There are five main reasons that cause subjective effects in the processes of information transformation in humans [1]:

- psychological (inadequate reflection, unrealistic prediction, adoption of a non-optimal strategy);
- motivational (incorrect formulation of the task, inconsistency of the subject's goals with the goals of management, which he is called upon to achieve);
- emotional (rapid and unstable changes in the transforming properties of the subject, caused by strongly acting external or internal causes);
- intuitive (an experience not formalized in the consciousness of the subject);
- evolutionary (slow changes in the transforming properties of the subject as a result of learning or forgetting).

The effect of these causes leads to three main consequences: additive, multiplicative and "own" constituents of subjectivity. The subjective components are: additive – loss of some useful information; multiplicative – inadequate information conversion in the receiver (distortion of reality); "own" – adding additional (useful or harmful) information not directly contained in the information coming from the object.

The study of the mechanism of emotions is of interest from four points of view:

- disclosure of heuristic decision-making principles with a sharp deficit of information, because these principles are largely based on

mechanisms that are close to the mechanisms of emotions. In order that in the future it becomes possible to transfer to the software agent the solution of some tasks related to the formation of tactics of behavior and the construction in the whole for the lower levels of control, first of all one must be able to describe and model the mechanisms of emotions;

- the study of the influence of the emotional tone of the operator on the quality of functioning in accordance with the principle of Yerkes-Dodson, whose idea is formulated as follows: "for each specific type of work and each person there is a level of emotional stress, in which the efficiency of the work will be maximum;

- empowerment of the agent with the mechanisms of emotions with a view to expanding its possibilities for adaptation to changing external conditions;

- the possibility of applying information assessments to analyze the mechanism of emotion.

The model of the emotion mechanism consists of the following main components: needs, desires (formation of purpose), formation of management, analysis and consciousness.

The management model by emotion can be represented as follows. At the highest level is the center of need, triggering the mechanism of control by emotion. It passes control information to the center of desire, according to which desires are formed (images of goals). In addition, from the center of the need, information in the form of demand enters the center of management formation.

The magnitude of the emotion can be either positive or negative. A negative emotion in the form of an activation signal enters the control system and activates the search for the control algorithm necessary to achieve the goal image. If the emotion is positive, the search control system stops the work and the system of fixing the control algorithm comes into operation. Emotion serves not only to search and fix the control algorithm, but also serves as a generalized information on the quality of management and the magnitude of the demand.

The change in the magnitude of the need causes an impact on the change in the image of the goal and can be represented as a direct effect on the parameters of the goal image of the desire center.

It can be assumed that there are three channels for influencing the mechanism of emotions. First, the center of consciousness can excite the center of the need. In doing so, the goals will be associated with any kind of needs. Secondly, the center of consciousness can affect emotions, suppressing or amplifying them depending on how they relate to the goals being formed. Such emotions will be called feelings. The third channel (the prohibition channel) is blocking for the lower control systems. In this case, the whole mechanism of emotion works, but control actions are forbidden by consciousness. The frequent work of the banning channel for the human body is not indifferent and engenders internal conflicts and emotional overstresses.

Consciousness in the mechanism of emotion performs a number of important functions. It forms mental models: the object, the executive bodies and the external environment, on which the management of emotions is pre-played in all the expected situations. This allows, first, to select the best control algorithms and fix them in the control center, and secondly, to create a positive emotional tone, which is a peculiar attitude of a person before it performs control directly on the site. This activates the person's attention, increases the speed of the control system and its noise immunity.

From the viewpoint of control theory, the mechanism of emotion can be viewed as a simplified search algorithmic adaptive control system [2; 3]. In the event that the situation is played on the mental models, it will be a system with a preliminary directional search for control on the models. The peculiarity of the management system by emotion is that it functions under sharply changing conditions, which are characterized by setting different goals, and the goals themselves are adjusted depending on the satisfaction of the need. This model imitates only the managerial aspects of

emotion and can be regarded only as the most rude approximation to those complex processes that occur in the mind of a person.

Despite the primitiveness of the model, it quite well explains many of the emotional reactions of a person.

The mechanism of emotion, which allows to provide adaptive control in case of variation of goals and deficiency of information about the state of the object, is very important to use in agents operating under conditions of bad known and sharply changing environment. Based on the proposed model of emotion, can be created programs that will give the intellectual agent properties that reflect the action of the simplest mechanisms of emotion. At the same time, it is possible to provide not only direct control by emotion, but also control with preliminary playback on the model of the external world, i.e. the agent will preliminarily "experience" his "actions" when searching for the most appropriate algorithm of action.

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