EMACOS – EMotions in Artificial COgnitive System: Callenges, Social Orders, and Actual Trends

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***Abstract*—The account for emotions in an artificial cognitive system represents one of the most actual and interesting problem for modeling a cognitive process. The main challenge here is associated with so-called problem of Explanatory Gap between the Brain- and Mind-inspired approaches. This implies the dual nature of emotions: subjective and comprehended self-appraisal from the "Mind" side, and the objective and measurable composition of neurotransmitters from the "Brain" side. Specific goals of emotion modeling should satisfy the actual social demands, which nowadays are connected with improvement of Human-Machine interface, as well as the with prevention and revealing the emotional health ricks. A special session on Emotions in Artificial Cognitive Systems is included in the Advanced Cognitive Technologies and Applications (COGNITIVE 2017) conference held in Athens, Greece. Four papers are focused on modern challenges, social demands, and actual trends in modeling the emotions.**

Keywords-emotions; artificial cognition, self-appraisal, social order; health risk.

I. MAIN CHALLENGES

At the beginning of Artificial Intelligence (AI) epoch, main challenge was modeling the rational reasoning. Since that time AI mainstream is aimed to produce artificial intelligent systems, which could perform certain tasks better than humans do (i.e., more efficient —more reliable, faster, more logically). Recently, however, priorities were shifted. The change in the paradigm was caused by several factors:

- Rapid development of high technologies (information technology, telecommunications, etc.) has led to acute problem of human interaction with artificial intelligent systems;
- The need to use automated intelligent systems (robots) in extreme conditions (unbearable for humans) requires them to adapt to extreme conditions and make non-trivial decisions;
- The health risks (diseases) associated with mental stress appeared to be a socially significant factor; the problem of diagnosis of stress states in course of professional intellectual activity is of paramount importance;
- The development of medical experimental techniques — Electrocardiography (ECG), Electro-encephalography (EEG), functional Magneto Resonance Imaging {fMRI), etc. — has reached high level providing the possibility to study the dynamics of the individual activity of the human brain areas (with sufficiently good resolution) in different (in particular, extreme) conditions. Such specific experimental data require relevant model to be properly interpreted and used for further advances in cognitive process modeling.

In this regard, the most urgent task becomes a simulation of human-like cognitive process, with its inherent qualities (personality, unpredictability, creativity) and features (like intuition and emotions).

Simulation of cognitive process in an Artificial Cognitive Systems (ACOS) nowadays implies inherently incorporation of rational reasoning and emotions. The challenge here is connected with dual nature of human emotions, i.e., the problem of Explanatory Gap [1], which had been formulated in 1983 but still remains actual (see Figure 1).

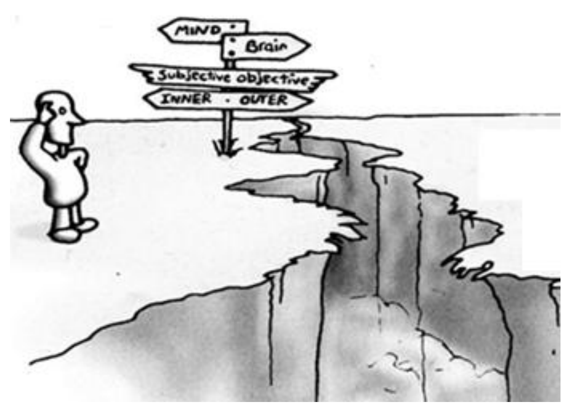

Figure 1. The Explanatory Gap between "Brain" and "Mind" (extracted from [1]).

On the one (psychology, i.e. “Mind”) hand, emotions are treated as subjective self-appraisal of current and/or future state. On the other (neurophysiology, i.e., “Brain”) hand, emotions are controlled by composition of neurotransmitters produced by certain sub-cortical structures (thalamus, amygdale, basal ganglia, etc.). This value is quite objective and experimentally measurable. Thus, the challenge is to “bridge” the gap between these two representations.

At present time, a variety of different approaches to modeling emotions in ACOS has been proposed and developed. At the one edge of this spectrum, there are the "pure Mind" models in the Active Agents paradigm [2]. It is assumed that Active Agents are endowed with consciousness and the ability of self-appraisal from the beginning, and the organization of their emotional space is analyzed to reveal the intrinsic logic underlying the emotions. On the other ("pure Brain") spectrum edge, the studies focus on modeling the brain processes that involve main neurotransmitters and hormones associated with emotions (like *noradrenaline, seratonin, dopamin*, etc., see, e.g., [3]). However, there is still the lack of synthetic models, which could join both, “Brain” and “Mind”, approaches.

Practical need of modeling the emotions is dictated by at least three application areas:

– Embedding emotions into artificial intelligent systems (robots) in order to make robots more humane; it could improve as the robot’s learning process (see, e.g., [4]), as well as human-robot interface;

– Formalization of human emotions in order to teach the robots to recognize it;

– Using the simulation of human emotions as a tool for diagnosis and treatment of emotional diseases.

Success in these fields can improve efficiency of human-robot interaction and expand the scope usage of robots in everyday life.

II. SOCIAL DEMANDS

Apart from pure scientific interest, modeling the emotions should satisfy actual social demands. They depend on current situation in technology, society, medicine, etc. Two current acute tasks could be pointing out.

A. Human-Mashine Interface

In today's world, artificial intelligent systems and robots are taking a larger place and applied in many different areas, partially replacing humans. However, fully automated systems are still quite rare, and most intelligent systems require operator intervention. In this case, the load on the operator is so great that the task of improving comfort of communication with the robot becomes paramount. It concerns the so-called "Human-robot interface".

Moreover, often the success of the operator depends on the speed of its response. It is known that emotional reaction manifests itself much more quickly, than logically argued and formulated command. If robots (artificial intelligent systems) could "read" the emotional response of the operator, it would have led to revolutionary changes in the sphere of high technologies.

B. Emotional Health Risks

All the previous arguments, as well as the huge information pressure on a person in the modern world, can cause (and leads to) the processes of cognitive disorders. First of all, it concerns the emotional loads, which may give rise to the stress response. The problem of stress caused by a cognitive load, as well as other stressful factors, acquires a State (federal) level, so as the fight against the epidemic of influenza. In this connection, comes to the fore the problem of stress diagnostics (preferably in the early states, i.e., when the stress itself is not yet developed, but there is a threat of stress), treatment (development of breeding methods of stress) and methods of rehabilitation for the post-stress states. These problems urgently require modeling the processes that take place in humans under stress, i.e., the stress models. On the base of these models, modern technologies provide a possibility to develop the methods of remote computer monitoring for humans in stressful conditions, which could help mitigate or even prevent the stress response.

III. ACTUAL TRENDS

The problem of incorporating the emotions and rational thinking in ACOS is now of significant interest and evokes a lot of studies. Since the emotional spectrum is very wide — from pragmatic and aesthetic to social emotions and emotional deceases, — the variety of approaches is wide as well.

In a special session Emotions in Artificial Cognitive Systems (EMACOS) held as a part of the COGNITIVE 2017 conference in Athens, Greece [5], four papers are presented that discuss the challenges, actual orders, and advances in representation of emotions an ACOS. They refer mainly to the Brain approach, yet [6] represents somewhat synthetic approach involving the “Brain” and the “Mind” spheres together.

O. Chernavskaya [6] considers the problem of the nature and mechanisms that could cause the Aesthetic Emotions. The proposed approach takes into account the dual nature of Emotions, which are considered as joint product of consciousness (associated with neocortex) and reflective response (sub-cortical structures regulating the composition of neurotransmitters). It is shown that study of Aesthetic Emotions, being seemingly not scientific (rather Art study) problem, provides the possibility to ‘open a gate’ to Explanatory Gap: strong emotions (‘*goosebumps*’) occur, when the “Brain does know, while the Mind cannot comprehend”. This could be caused by the *recognition paradox* (when some object seems familiar and unusual simultaneously).

Next three presentations refer to the Brain-inspired approach.

M. Talanov et al. [7] propose original NEUCOGAR model for emotion implementation in ACOS. It is based on well-known cubic representation of neurotransmitter composition suggested by Hugo Lovheim [3], but represents somewhat new and advanced approach to improvement of autonomous robotic systems with mechanisms of emotional revision and feedback. The results could be applied in a broad range of implementations: self-learning models, Human-Machine Interactions, study of psychiatric deceases, etc.

S. Parin, S. Polevaia, and A. Polevaia [8] focus on very important problem — prevention, diagnosis and treatment of the stress and shock emotional reactions. The authors reveal specific characteristics of human ECG, which could serve as the *stress markers* indicating the occurrence (or threat) of the stress state. An original three-component model is presented that successfully describes different phases of stress. On this basis, special Web technology are proposed, which provides the possibility to track online the stress process to diagnose (and even influence) remotely. They offer the Internet-based platform allowing perform the training with a fixed cognitive load. These proposals have good prospects for practical use.

E. Kazimirova [9] proposes interesting (yet debatable) idea of two-component model, where the internal and external 'libraries' should be connected by the hippocampus-like 'relay'. This hypothesis could be applied in large industrial intelligent systems for enhanced monitoring and protection.

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