Rough Set Theory may fill gap between Neurology and Cognitive Empathy

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Abstract. We still do not know exactly how brain processes are affected by nerve cell deaths in neurodegenerative diseases such as Parkinson's (PD). There is a gap between neurological and neurophysiological bases of the brain function and our unique, individual ways of thinking in order to solve different problems. We use many diverse ways to think, and they depend on different circumstances. Especially interesting are influences of intuition, feelings and emotions on way of our thinking. As we have mentioned before, psychophysical experiments and our amazing capability to recognize complex objects (like faces) in different light and context conditions argue against symbolic representation and suggest that concept representation related to similarities may be a more appropriate model of the brain function. By looking into anatomical and neurophysiological basis of different objects classifications, we propose to describe computational properties of the brain by rough set theory (Pawlak, 1991). Concepts representing objects physical properties in variable environment are weak (not precise), but psychophysical space shows precise object categorizations. Previously, one of us (Przybyszewski, 2008) has estimated brain expertise in classifications of the object's components by analyzing single cell responses in the area responsible for simple shape recognition (visual area V4). The model is based on the receptive field properties of neurons in different visual areas: thalamus, V1 and V4 and on feedforward (FF) and feedback (FB) interactions between them. The FF pathways combine properties extracted in each area into a vast number of hypothetical objects by using "driver logical rules", in contrast to "modulator logical rules" of the FB pathways. The FB pathways function may help to change weak concepts of objects physical properties into their crisp classification in psychophysical space.

In the present work, we extend our RS model by studying how emotions influence our vision by comparing psychophysical experiments with neurological findings. We have areas with different resources and depend on our emotions and thinking we switch them on and off. Certain resources are vital and never switched off: like cardio-vascular homeostasis and related respiration, or body posture. Other can get into conflict as they are incompatible because they compete for same resources, then one need to engage processes that have ways to manage such conflicts (Minsky, The Emotion Machine, 2006). If we do not

know solution of the problem we make a guess with attributes such as *intuition, insight, creativity or intelligence*. Working on some problems "reasoning by analogy" is our most usual way to deal with problems: What sort of things is this similar to? Have I seen anything like it before? What else does *k* remind me of? (Minsky, 2006). When solving problems, several differences are detected; the machine should first try to remove the most significant difference because this is likely to make a large change in the situation. *General Problem Solver* assigns different priorities to each kind of difference that it could detect (Minsky, 2006). Electrophysiological recordings support this hypothesis, looking at complex object, we recognize at first if it maybe a face and later if face what is its expression (Sugase et al., 1999). In RS approach it is in agreements with our previous model. In the first, very rough approximation we have to decide what kind of object we see. The feedback pathways tune lower areas to object's features that makes boarder set smaller. These processes allow recognition of the face expressions and it consequence should evoke in the observer right emotions (positive or negative). If observer has strong emotions before object's sensing, it may influence his/her perception: face expression may get wrong classification or even priority may reverse, subject may perceive angry faces all around. How can we explain these wrong classifications in RS or by whole and parts concept?

On another side, reduces emotion and feeling might play a roll in the decision-making failures (Elliot's case who lost parts of his frontal lobes and connections to amygdala, Damasio, 1995). In such case, subject lost his critical part of thinking, and could not get over one small problem to solve whole issue like when sorting documents spent all his time reading one document. Also lack or reduced connections between amygdala (emotions) and area IT (visual area responsible for face classification) is assumed to cause prosopagnosia (impossibility to recognize different faces). In summary, emotions have an important and decisive role in our perceptions.

We propose a model of emotional perception based on rough sets and rough mereology. Its principal component is a theory of continuous in time approximation of face's parts. This theory takes into account the continuous process of sensing influenced by emotions: of the observed face and the observer. As the approximation of face's parts may change in time, the solution might get different logical values.

References

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