The conceptual framework of information processing in action

Abstract

This work develops an interdisciplinary conceptual framework describing how animals process information in action. The thesis of the work is that animals are distributed, future-oriented, and memory-guided information processing systems. The biological body in the physical space has been described as processing sensory, somatosensory, and vestibular information. The results of computations done in neural networks processing information from the biological body are operationalized as biomechanical space. Complementarily, organisms infer the hidden causes behind the incoming information, exemplified as actions of other agents tied to their mental states. Such understanding of the latent causes is investigated in the Theory of Mind research and establishes a separate class of information processing operationalized as the inferred space. The differentiation between the biomechanical and inferred spaces reflects the ecological-enactive and Bayesian implementations of the free energy principle to biological systems. Both spaces coexist in the opinion of the scholars investigating the applications of the free energy principle, as well as researchers concerned with memory systems that distinguish between "procedural" and "declarative" memory systems. Careful analysis of the neural networks calculating the memory systems reveals the spatial architecture of these networks. A network called "the default mode network" engages in planning and inference of the mental states of other agents; a network called "attention network" processes information from the biological body, whereas the "control network" modulates engagement of the two previous networks with respect to the task's demands. The dynamics of computations within these networks have been related to the phenomenological experience of possibilities for actions known as affordances. The conscious experience is associated with the activity of structures in the parietal cortex known as "Gestalt areas". These regions overlap with regions included in all three brain networks described above, which is consistent with the richness of phenomenological experience that can span the biomechanical space processed by the attention network and the inferred space processed by the default mode network. As a result, the interdisciplinary conceptual framework describing information processing for the sake of action is used for the operationalization of the relations between action, the phenomenology of action, and the activity of the biological neural networks, which in turn shines a light on the individual differences in brain's architecture during the ontogeny.