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Geometry of Biological and Cognitive Time

Living phenomena displays characteristic and specific traits; among these, manifestations of temporality and of its role are particularly remarkable: retention (memory), protention (expectation), development, variegated biological rhythms, metabolic evolution, aging ... A philosophical introduction will focus on the issue of the "physicalist reduction" of biological phenomena. It will be briefly recalled that there is no relevant "theoretical reduction" within the history of physics itself, but it is more a matter of unification or radical conceptual revision. Our "logical way out" will be the proposal of biological autonomous frames as "theoretical extensions", in the terms of Logic, w. r. to physical theoretizing, where the key issue will be the possible "(non) conservativity" of biological theories w.r. to physical sub-theories. Our extended theory of physical time will then propose an abstract mathematical approach for describing the properly biological phenomena of retention and protention, by focusing on the ``extended present'' (in a phenomenological – and Varelian - perspective) as a result of protentional and retentional activities. Memory, as retention, is treated in some physical theories (relaxation phenomena, which will inspire our approach), while protention (or anticipation) seems outside the scope of physics. This allows us to introduce the abstract notion of "biological inertia". As a second example, we will observe that the usual physical (linear) representation of time is insufficient, in our view, for a satisfactory formalization of biological rhythms (heart beating, respiration, metabolic ...). In particular, the role of biological rhythms do not seem to have any counterpart in mathematical formalization of physical clocks, which are based on frequencies along the usual (possibly thermodynamic, thus oriented) time. We then suggest a functional representation of biological time by a 2-dimensional manifold as a mathematical frame for accommodating autonomous biological rhythms. The "visual"' representation of rhythms so obtained, in particular heart beatings, will provide some hints, by an analysis of a few clinical cases, towards possible applications of our approach to the understanding of interspecific differences or intraspecific pathologies. The 3-dimensional embedding space, needed for purely mathematical reasons, allows introducing a suitable extra-dimension for "representation time" with a cognitive significance.