From statistical signal processing to models in biology: the GENSA approach

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Our research concerns mathematical models to help understand and characterize the system that controls the proliferation, differentiation, migration and apoptosis (PDMA) of cells. This work is in the continuation of and actually extends[1], initially motivated by fundamental properties of the immune system, and especially, its degeneracy.

Our basic paradigm is that any living organism interacts with its environment through several steps: 1) the living system permanently senses its environment to perceive a multiplicity of events and changes in its surrounding; 2) it changes state depending on its perception of the environment and 3) it has a feedback effect on its environment according to its new state. Typically, PDMA reflects the interaction via fractones between stem cells and the extracellular matrix. We postpone to further work the introduction of network models to account for networks formed by living systems to share information through a common interior.

In this paper, we introduce the GENeric Sensor Actuator (GENSA) as a first step to a general theory for modelling the interactions involved in the creation and variations of the PDMA. The GENSA is fundamentally based on the Random Distortion testing (RDT) theory [2]. The RDT theory was introduced for statistical signal processing applications where the lack of prior knowledge and the degree of incertitude are such that standard solutions can become inefficient to detect signals in noise. The GENSA approach allows to model the living system ability to cope with uncertainty and changes in its environment and the "balanced sensitivity and specificity" of the signal detection it performs" [1].

References

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[2] D. Pastor and Q.-T. Nguyen, “Random Distortion Testing and Optimality of Thresholding Tests,” *IEEE Transactions on Signal Processing*, vol. 61, pp. 4161 – 4171, Aug. 2013.