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Integrative multi-scale modeling: Towards a morphogenetic approach

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In order to understand the onset, the development and dissemination of diseases, computational models have to be devised as a complement to experimental and clinical research. As a whole, the models cover a broad range of spatio-temporal scales that characterize the molecular, cellular and multi-organ-level scales. For any given level, different types of modeling approaches have been developed. They can be classified in three broad categories: discrete, continuum and hybrid models. In continuum models, variables are described as continuous quantities and their solutions are derived by solving ordinary, partial, or integro-differential equations. Discrete methods share the common view that the world has a granular nature. This vantage point is in some sense more natural than the continuum methods for describing individual entities such as cells. Generally, discrete models are governed by deterministic or probabilistic rules. Finally, composite and hybrid models combine features of both continuum and discrete methods. In these models, cells and tissues can be represented as discrete entities while growth factors, cytokines, nutrients, and cell waste products are represented as continuous fields. Multi-scale modeling can follow reductionist methods whereby system components are modeled separately and where "integration" is achieved by putting the pieces together like in a puzzle. An alternative route is morphogenesis whereby all model structures and functions co-evolve over time yielding much more integrated and realistic models. It is believed that model generation *via* morphogenesis starting from "embryonic" structures and using composite and hybrid methods holds great promises for future research in integrative computational biology.

Biography

Pridi Siregar holds a MSc in Computer Science and Artificial Intelligence, a PhD in Signal Processing and Computer Science and a Certificate of Specialization in Immunology (France). As a former Researcher, his work has been published in international scientific journals on topics ranging from mathematical modeling of biological systems to artificial intelligence and medical education. He left academia to create the company Integrative BioComputing (IBC), where he holds two international patents and sets up the scientific foundations of collaborative projects with French and international institutions.

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