Nature-Inspired Biomedical Image Analysis for Precision Medicine

Natural phenomena and mechanisms have always intrigued humans, inspiring the design of effective solutions for real-world problems. Indeed, fascinating processes occur in nature, giving rise to an ever-increasing scientific interest. In everyday life, the amount of heterogeneous biomedical data is increasing more and more thanks to the advances in image acquisition modalities and high-throughput technologies.

The automated analysis of these large-scale datasets creates new compelling challenges for data-driven and model-based computational methods. The application of intelligent algorithms, which mimic natural phenomena, is emerging as an effective paradigm for tackling complex problems, by considering the unique challenges and opportunities pertaining to biomedical images. Therefore, the principal contribution of computer science research in life sciences concerns the proper combination of diverse and heterogeneous datasets - i.e., medical imaging modalities (considering also radiomics approaches), Electronic Health Record engines, multi-omics studies, and real-time monitoring - to provide a comprehensive clinical knowledge.

In particular, our research focuses on the main nature-inspired computational techniques applied to medical image analysis tasks, namely: physical processes, bio-inspired mathematical models, Evolutionary Computation, Swarm Intelligence, and neural computation. These frameworks, tightly coupled with Clinical Decision Support Systems, can be suitably applied to every phase of the clinical workflow. We show that the proper combination of quantitative imaging and healthcare informatics enables an in-depth understanding of molecular processes that can guide towards personalized patient care.

References:


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