Frontiers in Bioscience Landmark

Special Issue

Dynamic Diseases: Mathematical Informed Expert and Knowledge Computing Technology-based Computational Medicine in Complex Systems

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Message from the Guest Editor

Dear Colleagues,

Dynamic diseases are characterized by striking changes in the dynamic aspects of bodily functions. They require a computational medicine-based integrative approach directed at the analysis of underlying parameters in ambiguous conditions. This strategy is applied to the development of treatment options by considering emerging dynamic biomarkers which flag critical, life-saving and life-quality maintaining transitions, as well as decisions for dynamic diseases in which the “right time” for medical intervention is required. Computational methodologies and mathematically-informed modeling now play an increasing role in the investigation of mechanisms that are central to the diagnosis, prognosis, prediction and treatment of dynamic human diseases. These progressive processes have given rise to computational medicine, which uses advanced mathematical and simulation approaches to model the human body as a complex system that ranges from molecules, cells and tissues to the organs of the entire body. Through its transformative power on healthcare, technology can enable optimal patient care by allowing sophisticated use of information technology and by using a mathematically informed approach. Computational medicine thus allows the generation of models based on theory and knowledge that are able to capture singular and individual properties concerning health and disease with the aim of accurate decision-making.

Equifinality posits that multiple paths are directed at and linked to a common end state with the overarching aim of unifying sciences. It is critical in computational medicine, which lies at the interface of computational modeling and medicine. This integration enables individualization and personalization of medical decision making to enhance health outcomes, while at the same time

limiting the burden on healthcare. To attain this goal, dynamic precision medicine or personalized medicine, including the tailoring of treatment to each patient's individual characteristics, focuses on giving the right treatment to the patient at the right time. Hence, anticipation, control and management of the complexity of unexpected events can be achieved based on detailed information obtained from conventional biomarkers, genetic cues, and phenotypic and/or psychosocial characteristics. These are critical for distinguishing amongst patients who display similar clinical features within a sub-group.

Health is considered to be a multidimensional, complex, and adaptive state arising from a myriad of non-linear interactions across micro-, macro- and nano-level variables and a biological blueprint. It extends over a broad spectrum of diseases including neurological and biological diseases, as well as cancer, epidemics, vascular disorders, medical oncology, mental disorders, immune-system disorders and virological problems, amongst many others. Accordingly, the preliminary aim of this special issue is the integration of progressive computational medicine and related disciplines so that accuracy and timely intervention within such hierarchically layered complex systems can be attained. To address the intricate problems that emerge in dynamic diseases, it is important to develop systems in conjunction with advanced mathematical algorithms that touch on chaos, fractals, multifractional, fractional calculus, quantum, wavelet, entropy-based applications, machine learning and artificial intelligence amongst others. Through such cross-domain understanding, we anticipate this Special Issue will open up new frontiers in which clinical knowledge and computational methodologies act as a unifying framework to promote further research and development of theories and applications, as well as to serve human health at large.

Potential topics of the special issue include but are not limited to:

- Computational diagnostics
- Computational imaging and simulation technologies in biomedicine
- High-performance biocomputing
- Data analytics-based models
- Dynamic precision medicine
- Advanced medical image/signal processing
- Integrative machine-learning and neuroscience
- Computational modeling of medical complex systems
- Learning-based models in medical imaging (MRI, EEG, X-rays, etc.)
- AI applications in medicine
- Multiscale entropy and applications in medicine and biology
- Neural systems mimicking neural functioning
- Neural information processing for biological and neurological systems
- Fractals and multifractal methods in dynamic diseases
- Fractional calculus in complex dynamic diseases
- Computational brain connectomics
- Physics Informed Neural Networks (PINNs)
- Fractional Computing System
- Comprehensive omics profiling for precision medicine

- Non-invasive assessment of disabilities
- Video analytics for human behavior understanding
- AI for e-patients, e-medicine and e-health
- AI for healthcare & image-guided interventions
- Fractional dynamic processes in medicine
- Personalization in practice: dynamic computational modeling
- Computational imaging and simulation technologies in biomedicine

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Guest Editors

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