Complexity

Special Issue on

Frontiers in Data-Driven Methods for Understanding, Prediction, and Control of Complex Systems

CALL FOR PAPERS

In the field of complex systems, there is a need for better methods of knowledge discovery due to their nonlinear dynamics, great number of interconnected variables, multiple interacting parts, and feedback loops. The consequent limited predictability poses severe practical and conceptual issues, for both understanding and control. The coexistence of ordered, disordered, and chaotic phases in their evolution requires the development of reliable metrics for their characterization. Self-organization and emergence are other important aspects, which, by generating new information and structures, challenge traditional data analysis methods, from pattern recognition to prediction and model building. More accurate and robust identification techniques are therefore in great demand.

All these difficulties become even more severe when the elements forming the complex systems have some capacity of adaption and learning, as is evident in the investigation of phenomena involving living organisms and humans. It should also be remembered that, even if a lot of data is generated today, important aspects of complex systems can be poorly accessible for measurements, due to the transient nature of the events, the out of equilibrium conditions, or the perturbative character of the diagnostics. As a consequence, remote sensing and external detection techniques are widely used, with the consequent requirements to perform severely ill-posed mathematical inversions to obtain the desired information. Moreover, the nonstationary character of many phenomena requires new techniques to identify manifolds and strange attractors, using only short time series. It should also be remembered that history and memory effects also violate the basic assumptions of most traditional data analysis techniques, such as the i.i.d. (independent sampled and identically distributed data) hypothesis. All these conditions render the assessment of causality dependencies very challenging, in particular in the case of systems in the chaotic regime.

In this special issue, we would like to collect both original research and review articles related to new developments in data analysis tools, specifically focused on addressing the aforementioned challenges posed by complex systems. The contributions can cover all the aspects of dealing with complexity from understanding to prediction and control. The applications of the analysis techniques can refer to both natural and man-made systems, from physics and chemistry to biology, economics, and ecology.

Potential topics include but are not limited to the following:

- Machine learning for understanding, prediction, and control of complex systems
- Identification of chaotic dynamics
- Complex networks
- Genetic programming for knowledge discovery in complexity
- Inversion techniques for the investigation of ill-posed problems
- Neural and Deep Learning applied to nonlinear phenomena
- Cellular automata
- Adaptive, data-driven approaches aimed at pattern recognition, causal inference, and learning in nonstationary environments

Authors can submit their manuscripts through the Manuscript Tracking System at https://mts.hindawi.com/submit/journals/complexity/fmlm/.

Papers are published upon acceptance, regardless of the Special Issue publication date.

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