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Special Issue Reprint

## Causality and Complex Systems

**Edited by: Jiang Zhang, Peng Cui and Hector Zenil**

Complex systems are unified wholes formed by many interacting units. One key source of their complexity lies in the intricate entanglement of causal structures. A notable feature of these systems is the phenomenon of emergent causality, where stronger causal relationships may arise at the macro-scale rather than the micro-scale, as seen in fields like statistical mechanics. This Special Issue focuses on "**Causality and Complex Systems**", examining the interplay of causal relationships and the emergence of causal structures within complex systems. The 17 articles in this issue encompass a broad spectrum of topics, ranging from theoretical frameworks to practical applications, with the shared goal of advancing our understanding of causality in dynamic, interconnected systems. Key contributions of this issue include novel theoretical frameworks for quantifying causal emergence, innovative causal machine learning algorithms, and information-theoretic measures for analyzing causality. Methodological advancements are also presented for causal discovery in complex and nonlinear systems. Furthermore, this issue features interdisciplinary applications across neuroscience, biology, sociology, and environmental science, demonstrating the versatility of causal methods in addressing real-world phenomena. Ultimately, this Special Issue enhances both the theoretical understanding of causality in complex systems and provides practical tools and methodologies to tackle challenges in data-driven research.



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