

**Understanding Multivariate Causal Dependencies
from Time-Series Observations**

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Studies of natural systems are increasingly relying on direct observations of co-varying variables. The causality and feedback inherent in these dependencies results in characteristics, which have been described as emergent, a term that indicates that the overall behavior could not have been predicted from the knowledge of the characteristics of the individual variables alone. This suggests that the interdependence between variables creates a whole that is interesting and relevant in its own right. Therefore, through the simultaneous measurement of several variables, it should be possible to unravel dependencies between them that are otherwise not possible. We use process networks, which refer to a network of feedback loops and associated time scales that depict the magnitude and direction of flow of matter, energy, and/or information between different variables to develop an understanding of self-organized systems. In this talk I will expose methods to characterize information flow between variables interacting in a complex system, and develop an understanding of emergent features with examples from ecohydrologic systems.