Identifying causal relationship in partially deterministic systems from time-series data

Masato S. ABE[*1,2], and Shin-ichiro NAKAYAMA[3]

[1]National Institute of Informatics, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan

[2]JST, ERATO, Kawarabayashi Large Graph Project, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430,Tokyo, Japan

[3]National Research Institute of Fisheries Science, 2-12-4, Fukuura, Kanazawa-ku, Yokohama, Kanagawa, Japan

E-mail: mabe@nii.ac.jp

Identifying causal relationship from time-series data is important for predicting and controlling the complex systems in various fields, ranging from ecology to social science and economics. Recently, a novel method, convergent cross mapping (CCM), was proposed for detecting causality between a pair of time-series [1]. This method is based on nonlinear space state reconstruction, thus is applicable for deterministic nonlinear dynamical systems. However, biological or social systems are sometimes "partially deterministic", which contains both deterministic and stochastic processes. In this presentation, we will report the limitation of previous methods including CCM and extend this method to detect causality in nonlinear systems, even when it contains stochastic processes. We conducted numerical experiments for low- to high-dimensional systems to validate our method. Moreover, we will show application examples for biological and social data.

References

[1] G. Sugihara, R. May, H. Ye, C. H. Hsieh, E. Deyle, M. Fogarty, and S. Munch, "Detecting causality in complex ecosystems", Science, 338, 496-500 (2012).