若手研究者インターナショナル･トレーニング･プログラム(ITP)

バイオインフォマティクスとシステムズバイオロジーの国際連携教育研究プログラム 応募書類

Name: Risa Uechi
Title: RMT assessments of the latent Information embedded in the large-scale data
Institute: Bioinformatics Center, Institute for Chemical Research, Kyoto University
Partner institute of your choice：Center for Polymer Studies, Boston University
Duration of your choice: April 4, 2013 – July 2, 2013

Research Objectives

I will learn statistical methods to evaluate large-scale data such as gene transcriptomic data, market stock exchange data under the supervision of Dr. H. Eugene Stanley and Dror Y. Kenett at Center for Polymer Studies, Boston University. Dr. H. Eugene Stanley has contributed many research fields such as economics, molecular biology especially DNA modeling and physical and social networks theory. He is also the pioneer of econophysics which is the interdisciplinary research field of both physics and economics. In the laboratory of Dr. H. Eugene Stanley, there are a lot of people who came from variable research fields such as bioinformatics, astrophysics and economics, therefore, numerous unique researches are possible. It should be variable experience to stay in Dr. H. Eugene Stanley's laboratory. This is the reason why I would like to apply for the ITP program and choose the host supervisor as Dr. H. Eugene Stanley.

It is remarkable in the field of theoretical biology such as bioinformactics, systems biology and biophysics, the properties or 'common law' behind the complex nonlinear phenomena. It is also one of the primary topics in complex phenomena. Especially in complex network systems, the power law is studied and investigated in many network system and known as the 'common law' in complex network systems. If the study of 'common law' improved, there will be benefits to many research fields not only to bioinformatics. Akutsu laboratory has been studied many theoretical model and softwares to examine metabolic networks using KEGG data base such as impact degree calculating program and so on. I also studied the conservation law in complex phenomena, mainly in competitive systems, at Akutsu laboratory as previous research projects. My research results indicate that there exists other 'common law' in complex nonlinear phenomena including biology, ecology and economics using calculus of variations. My research objective in three-month ITP program is to learn the method of RMT assessments to evaluate latent information in transcriptomic data and recent network percolation theory and search another relation in large-scale data. I will also interchange opinions with other members of Boston University and discuss the research topics. I will also join international communications and expand my knowledge. After learning these statistical methods, I will devote the analysis of impact degree using RMT assessments.

Research Plan

1. Research Background

Nonlinear dynamical systems characterized by self-interactions, self-organizations, spontaneous emergence of order, dissipative structure and nonlinear cooperative phenomena have shown essential roles in natural sciences, as well as economy, ecology, and environmental sciences [1]. Nonlinear dynamical systems are difficult to handle unlike linear dynamical systems because their complex interactions and structures make it so hard to understand a response of a system, which may exhibit no simple laws or orders. However, in terms of natural sciences, conservation laws, symmetries and orders in nonlinear dynamical systems are expected to exist even in biology, ecology, and economy. The important examples in the field of ecology are those of Malthus for a population analysis, Alfred Lotka and Vito Volterra for predator-prey differential equations known as Lotka-Volterra (LV) equation. Also, in the field of economy, a conserved quantity in the system of business cycle is studied and this business cycle model is regarded as a predator-prey type competitive system, and also a mathematical model for Lanchester Strategic Management is known as a predator-prey type competitive system.

2. Model and Methods

Random Matrix Theory (RMT) is a tool that was originally developed and used in nuclear physics by Wigner and Dirac, et al., in order to explain the statistics of the energy levels of complex quantum systems. Recently, it has been applied to many fields other than physics such as biology (transcriptomic data) and economic data. By using RMT, we are able to discern to what extent the data correlation are a result of random noise rather than important system information [2-3].

We set the research plan is to focus on RMT, and work on better understanding the meaningful eigenvectors, and how these change when the state of the market changes.

3. References

[1] Lisa Uechi and Tatsuya Akutsu, Conservation Laws and Symmetries in Competitive Systems, *Progress of Theoretical Physics Supplement,* No. 195, 2012, 210.

[2] H. E. Stanley, V. Afanasyev, L. A. N. Amaral, S. V. Buldyrev, A. L. Goldberger, S. Havlin, H. Leschhorn, P. Maass, R. N. Mantegna, C.-K. Peng, P. A. Prince, M. A. Salinger, M. H. R. Stanley, and G. M. Viswanathan, "Anomalous Fluctuations in the Dynamics of MI. Complex Systems: From DNA and Physiology to Econophysics," Physica A 224,302-321 (1996).

[3] Dror Y. Kenett, Yoash Shapira, and Eshel Ben-Jacob, RMT Assessments of the Market Latent Information Embedded in the Stocks' Raw, Normalized, and Partial Correlations, Journal of Probability and Statistics (2009).

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