MINI SYMPOSIUM

Computations, Brains and Machines

July 31 (Thursday), 2014
13:00 – 16:45
1F Seminar Room, BSI Central Building

13:00-14:00
Limitless Arity Multiple Testing Procedures for Combinatorial Hypotheses
Prof. Koji Tsuda
University of Tokyo

14:00-15:00
Human choice and risk-sensitive sequential decision making
Dr. Takayuki Osogami
IBM Research – Tokyo

15:00-15:15 Break

15:15-16:15
Unsupervised Change Detection
Prof. Masashi Sugiyama
Tokyo Institute of Technology

16:15-16:45
Bayesian Information Geometry, Restricted Boltzmann Machine and Contrastive Divergence
Dr. Shun-ichi Amari
RIKEN Brain Science Institute

Host:
Hiro. Nakahara Lab for Integrated Theoretical Neuroscience

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Limitless Arity Multiple Testing Procedures for Combinatorial Hypotheses

Prof. Koji Tsuda
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In biology, a trait is often caused via interaction of multiple factors including genetic variants, epigenetic status and environmental conditions. To discover such combinatorial factors from data, pattern mining methods including item set mining are potentially useful, but they have barely been used by experimental biologists due to difficulty in assessing statistical significance. If n elementary factors are available, the number of all combinatorial factors is 2^n -1, preventing conventional multiple testing methods from yielding statistically significant discoveries. Our algorithm, termed limitless arity multiple testing procedure (LAMP), counts the number of testable hypotheses, thereby avoiding the combinatorial explosion problem while rigorously controlling the family-wise error rate under a specified level. It can be used in all kinds of pattern mining algorithms. LAMP discovered a statistically significant combination of as many as eight transcription factors associated with breast cancer, which could not be found by conventional multiple testing methods including FDR-based ones.

[1]A. Terada, M. Okada-Hatakeyama, K. Tsuda* and J. Sese*: Statistical significance of combinatorial regulations, PNAS, 110(32):12996-13001,2013.

[2]S. Minato, T. Uno, K. Tsuda, A. Terada, J. Sese: A Fast Method of Statistical Assessment for Combinatorial Hypotheses Based on Frequent Itemset Enumeration, ECMLPKDD, 2014.

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Brain Science Institute RIKEN

Human choice and risk-sensitive sequential decision making

Dr. Takayuki Osogami

IBM Research – Tokyo

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We study sequential decision making of a machine providing services to humans with particular focus on the complexity of human behavior and the sensitivity to risk. For example, a machine recommends a set of products to a human, the human purchases one of the recommended products, and this process continues. Our first focus is on human choice, which can depend on the choice set in complex but systematic ways. For example, adding a dominated item (decoy) into the choice set can increase the choice probability of a dominant item, which is known as the attraction effect. To model such complex human choice, we propose a choice model based on a restricted Boltzmann machine. We show both analytically and empirically that our choice model can represent the attraction effect and other typical choice phenomena that appear in human choice. Our second focus is on consideration of risk-sensitivity in sequential decision making, where following optimal policy can lead to inconsistent decisions over time. We show how to make consistent decisions by the use of iterated risk measures. We also establish the equivalence between the sensitivity to risk and the robustness against uncertainty. A part of this research is supported by JST, CREST.

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Unsupervised Change Detection

Prof. Masashi Sugiyama
Tokyo Institute of Technology

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We consider the problem of detecting change in two sets of samples, and introduce two approaches: distributional and structural change detection.

Distributional change detection estimates a divergence between the probability densities behind the two sets of samples, such as the Kullback-Leibler divergence, Pearson divergence, and L2-distance. We first explain that the two-step approach of estimating the probability densities and computing the divergence from the estimated densities results in systematic under-estimation of the divergence. Then we introduce methods to direct estimate the divergence without estimating each density.

Structural change detection tries to identify change in element-wise dependency structure in multi-dimensional samples. We first consider the Gaussian sparse covariance selection setup and introduce approaches based on LASSO and fused-LASSO. Then we extend our discussion to non-Gaussian Markov networks, which generally suffer computational intractability of the normalization term, and introduce the importance sampling technique and the score matching method. Finally, we cover a method to directly compare two Markov networks without identifying each Markov network.

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Bayesian Information Geometry, Restricted Boltzmann Machine and Contrastive Divergence

Dr. Shun-ichi Amari

RIKEN Brain Science Institute

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The talk is a presentation of non-baked ideas concerning Bayesian information geometry and its application to the Restricted Boltzmann Machine (RBM). RBM provides a good framework of Bayesian statistics in terms of exponential family. We apply this idea to the unsupervised learning, in particular, learning by minimizing the KL-divergence and contrast divergence. This is not a finished work, not on-going work but just a work to start. Lots of discussions and proposals for collaborations are welcome.

Host:
Hiro. Nakahara   Lab for Integrated Theoretical Neuroscience