

Preface

— From the Physics of Material to the World of Information and Back —

Our modern-day life is full of high-tech products with capabilities of massive information processing such as personal computers, mobile phones and digital cameras. Increasing activities in research and development of these products have been exerting strong influences on more basic researches concerning unconventional frameworks of massive information processing. The paradigm of probabilistic information processing is one of the most promising and best-paved paths to follow in this direction.

Probabilistic information processing lies at the interface of several different disciplines including statistical science, statistical mechanics, and information science. More precisely, many of the models of massive probabilistic information processing have close formal similarities to the models of magnetic materials; statistical mechanics is particularly suited to analyze these models in a unified, systematic way. In fact many successful researches have been reported for more than a decade in the applications of advanced mean-field theory, spin glass theory and related methods to error-correcting codes, image processing, mobile communications technology, probabilistic inference in expert systems, to name a few. Conversely, many problems in probabilistic information processing have created research ideas in statistical mechanics.

A natural philosophical question is why statistical mechanics, a branch of physics to treat the properties of macroscopic materials, is useful for the analyses of information of massive quantity. The key element seems that both macroscopic materials and massive amount of information are composed of very many elements that are interacting (correlated) in some way or another as depicted in Fig. 1. This close proximity in the basic starting points of these disciplines has been lying behind the strong activities in this interdisciplinary field since around 1990 when the problems of error-correcting codes, image processing, optimization problems and probabilistic inference were gradually recognized as attractive topics by people working on spin glasses and related problems. We may therefore expect with good reasons that similar (or maybe unexpected) developments in this direction will continue for many more years to come, which serves as a strong motivation to organize workshops like the present one with participation of active researchers and young students.

The present workshop is entitled *Physics and Information*, a part of the 2003 Hayashibara Forum *Chance and Necessity*, and has been organized as a Joint Workshop of (and is co-sponsored by) the Hayashibara Foundation and Grant-in Aid for Scientific Research on Priority Areas *Statistical-Mechanical Approach to Probabilistic Information Processing (SMAPIP)*. This workshop covers the following topics:

1. Statistical-mechanical models for information processing.
2. Information geometry, advanced mean-field theory and belief propagation.
3. Spin glass theory and coding theory.
4. Probabilistic image processing.
5. Probabilistic models for evolutionary computation.

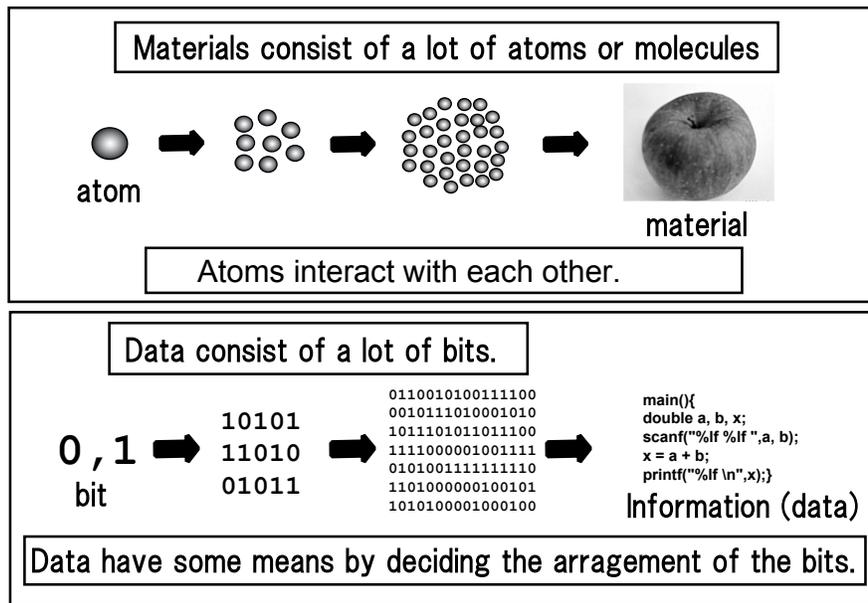


Figure 1: Physics of material and information processing.

6. Bayesian analysis and machine learning theory.
7. Statistical-mechanical analysis in mobile communication mechanism.
8. Computational analysis of probabilistic information processing.
9. Routing control of packet flow using artificial neural network.
10. Monte Carlo methods including the extended ensemble method.
11. Bayesian network.
12. Other statistical-mechanical approaches to probabilistic information processing.

The organization committee of this workshop consists of:

- M. Suzuki, Hayashibara Forum 2003 General Chair (Tokyo University of Science)
- H. Nishimori, Organizing Committee Chair (Tokyo Institute of Technology)
- Y. Kabashima, Program Chair (Tokyo Institute of Technology)
- K. Tanaka, SMAPIP Head Investigator (Tohoku University)
- T. Tanaka (Tokyo Metropolitan University)

We thank all participants and hope that this workshop will be very successful and contribute to the developments of this strongly interdisciplinary field.

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