Ryoji Miyazaki
National Institute of Informatics
Application of coherent Ising machine to compressed sensing

There has been great interest in developing machines for solving combinatorial optimization problems that have lots of practical applications. The coherent Ising machine (CIM), based on network of optical parametric oscillators representing artificial spins, is a promising machine for such a purpose. The CIM searches for the ground state of the Ising Hamiltonian onto which our target optimization problem is mapped. Investigation of the CIM has demonstrated its efficiency for the Ising problems[1,2]. To further evaluate the ability of the CIM for practical optimization problems, here we numerically simulate the CIM for compressed sensing.

Compressed sensing is a technique for recovering signals from lower-dimensional compressed data[3]. We cannot reproduce them in general. Prior knowledge on sparsity of the original signals, however, makes it possible. Inference of the signals can be formulated as an optimization problem via LASSO[4]. We run numerical simulations of the CIM to solve the problem and compare resulting error rates with theoretical predictions for the possibility of reconstruction derived by an analytical method developed in statistical physics. We set a problem in which entries of signals are limited to be binary numbers. This problem is represented with an Ising Hamiltonian with the Zeeman term. Obtained results with the CIM are in good agreement with the theoretical prediction. We further tackle an extended problem in which the entries are general discrete numbers for using the CIM for compressed sensing of images. Simulation results of the CIM are consistent with prediction of the theory we derive also in this setting.

[1] T. Inagaki, et al., Science 354, 603 (2016).
[2] P. L. McMahon, et al., Science 354, 614 (2016).
[3] D. L. Donoho, IEEE 52, 1289 (2006).
[4] R. Tibshirani, J. R. Statist. Soc. B 58, 267 (1996).