論文の内容の要旨

論文題目　Quantum Annealing in Statistical Machine Learning
（統計的機械学習における量子アニーリング）

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（本文）Machine learning is a process for improving the performance and behaviors of a machine through the use of empirical data. The aim of machine learning is to extract hidden properties in data and make predictions yet to be observed. We humans decide our behaviors based on knowledge learned or abstracted from past experiences and information. However, a large amount of information or data makes it difficult for us to extract useful information and develop accurate solutions to problems. Therefore, it is important to develop systems that automatically learn underlying mechanisms in observed data. Machine learning is related to many fields: probability theory and statistics, data mining, information theory, computational neuroscience, theoretical computer science, and statistical physics. We propose a novel machine learning framework based on quantum mechanics. Basically, machine learning is formulated as an optimization problem. Simulated Annealing (SA) is a well-known physics-based approach for solving optimization problems in machine learning. SA is used to solve problems by using a concept of statistical mechanics, temperature. In physics, quantum annealing (QA) has attracted much attention as an alternative annealing method of optimization problems through quantum fluctuations. QA is the quantum-mechanical version of SA. We developed two QA variant learning algorithms of the variational Bayes inference and the Gibbs sampler, which are common learning algorithms. The proposed learning algorithms can be applicable to problems to which these conventional algorithms are adaptable. We empirically demonstrate that our QA-based learning algorithms works better than SA-based learning algorithms in the unigram mixture model, latent Dirichlet allocation , hidden Markov model and the Dirichlet process mixture models for clustering documents, extracting topics of documents, predicting users' preference of music artists, and modeling web page visits of users.