



The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

Statistical and Structural Properties of Generative Models

By

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ABSTRACT

Generative models have received considerable interest in modern machine learning and statistics as a method for data generation and representation learning. Despite their remarkable empirical success, the theoretical properties were less justified, especially those of generative adversarial networks (GANs). This motivates the first thrust of this thesis, which is statistical analysis of f-divergence GANs. Our theory gives rise to a new class of GAN algorithms with higher statistical efficiency and sheds light on the statistical problems including the relationship between GAN and MLE. We also provide a unified view of GAN and variational autoencoders under the principled framework of bidirectional generative models. In addition, we extensively adapt our methods to practical tasks in computer vision and natural language processing and achieve state-of-the-art performance. The second part of this thesis shifts the focus to the structural properties of generative models. An emerging field regarding this is disentangled representation learning that starts with the premise that real-world data is generated by some explanatory factors and aims at recovering those factors as well as their underlying structure. We propose a method for causal disentanglement learning based on a bidirectional generative model with a causal prior and prove the identifiability and asymptotic convergence of our algorithm. Finally, we develop a nonparametric method to learn causal structures from observational data.

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(Open to all faculty and students)

The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).