Guest Editorial

WELCOME to the first issue of the JOURNAL ON SELECTED AREAS IN INFORMATION THEORY (JSAIT) focusing on Deep Learning: Mathematical Foundations and Applications to Information Science.

Information theory and artificial intelligence have been connected since inception. In 1950, only two years after his landmark paper, Claude Shannon built and demonstrated his famous maze-solving mouse, Theseus. In August 1955, McCarthy, Minsky, Rochester, and Shannon coauthored a proposal for a summer seminar at Dartmouth that introduced the term "artificial intelligence" for the first time. Neural networks were explicitly discussed as an area to study. Their proposal states *"Neuron Nets: How can a set of (hypothetical) neurons be arranged so as to form concepts. Considerable theoretical and experimental work has been done on this problem [..]. Partial results have been obtained but the problem needs more theoretical work."*

Sixty-five years later, we are still fascinated by neural networks and, despite tremendous effort in industry and academe, neural networks remain an active area of research. This special issue covers several areas where modern deep learning research intersects with information theory, optimization, coding theory, and signal processing. We focus on foundational topics such as new network architectures and better training, sample complexity, and generalization bounds. Specifically, a number of the papers focus on supervised learning and how information-theoretic methods can provide bounds for generalization, convergence guarantees, and feature selection. Several others focus on unsupervised learning through the use of deep generative models such as autoencoders and generative adversarial networks. Several others study the use of error-correcting codes for distributed learning and how deep learning can improve the performance of communication systems through better error correction.

In addition to the research papers, the special issue includes three tutorials on emerging topics in the intersection of information theory and deep learning: the information bottleneck, deep learning for communication systems, and deep learning for inverse problems. These tutorials illustrate how classical information-theoretic concepts such as channel capacity, mutual information, source and channel modeling as well as coding theory lead to a better understanding of deep learning fundamentals and new applications in important areas.

As the guest editors, we would like to thank the authors of all submitted manuscripts. Additionally, we would like to thank the thorough, diligent, and timely referees who collectively submitted over one hundred reviews. We had to make several difficult choices as we received more good papers than could be accommodated. We hope our readers will share our enthusiasm for this special issue and this new journal.

RICHARD BARANIUK
Rice University
Houston, TX 77005 USA

ALEX DIMAKIS
University of Texas at Austin
Austin, TX 78712 USA

NEGAR KIYAVASH
École Polytechnique Fédérale de Lausanne
1015 Lausanne, Switzerland

SEWOONG OH
University of Washington
Seattle, WA 98195-2350 USA

REBECCA WILLETT
University of Chicago
Chicago, IL 60637 USA

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