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Artificial Intelligence in Electromagnetics

The words *artificial* and *intelligence*, put together, make an interesting pair. We view *intelligence* as a noble characteristic. *Artificial*, on the other hand, has a negative meaning—fake, false, and not natural. Therefore, connecting these two words into a descriptive phrase invokes confusing connotations.

Artificial intelligence (AI) attributes a positive human quality (intelligence) to a machine, thus making it artificial. Elon Musk said, "AI will be the best or worst thing ever for humanity." Bill Gates characterized AI by saying, "The world hasn't had that many technologies that are both promising and dangerous—you know, we had nuclear energy and nuclear weapons." Confusing? Absolutely! AI has the potential for "good" and "bad." This issue of *IEEE Antennas and Propagation Magazine* (*APM*) offers three "good" review contributions updating readers on the applications of AI in our field of antennas and propagation (AP).

In the first article, Campbell et al. provide an overview of the state of the art (SoA) of the use of deep learning (DL) methods in problems of interest to the AP community, including forward modeling, inverse scattering and remote sensing, and inverse design (optimization). They also envisage DL's potential impact on the IEEE Antennas and Propagation Society and discuss the application of new hardware advancements for computational electromagnetic simulations. They report several useful references to assist beginners in getting started with using DL in their own research.

We hope this special cluster will inspire new ideas for and applications of AI for AP that have not been explored yet.

The second work, by Zardi et al., focuses on reviewing the SoA of a set of AI applications in adaptive and reconfigurable antenna arrays: adaptive nulling; wireless localization; multiple-input, multiple-output communications; element failures; and array calibration. After introducing three types of AI beamforming architectures and their applicability to AI control, the authors give an overview of example applications of AI-controlled adaptive and reconfigurable arrays in the five areas, with comparative evaluations and discussions.

In the third contribution, Li et al. provide a review of recent works on the application of machine learning (ML) techniques to biomedical imaging applications. After introducing the theoretical background of well-established and more recent ML techniques, the authors discuss the application to biomedical signal processing and imaging algorithms of two classes of ML methods—namely, direct data-driven approaches and those that learn prior knowledge in conventional inversion algorithms.

In closing, we wish to express our gratitude to *APM*'s Editor-in-Chief Prof. Francesco Andriulli, for kindly accepting the proposal of this special issue and for his support. Special thanks goes to Christina Tang-Bernas, *APM*'s editorial assistant, for her professionalism and prompt assistance. We would like to thank the authors and reviewers for their effort in this issue. We hope this special cluster will inspire new ideas for and applications of AI for AP that have not been explored yet.

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