BOOKS *et al.*

COMPUTER SCIENCE

AI for the M.D.

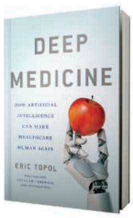
Deep learning could give doctors of the future more time for the human aspects of health care

By **Peter Szolovits**

Freed from a variety of tasks by artificial intelligence, doctors will have more time with patients, Topol predicts.

In 1970 in *The New England Journal of Medicine*, William Schwartz predicted that by the year 2000, much of the intellectual function of medicine could be either taken over or at least substantially augmented by "expert systems"—a branch of artificial intelligence (AI). Schwartz hoped that the medical school curriculum would be "redirected toward the social and psychologic aspects of health care" and that medical schools would attract applicants interested in "behavioral and social sciences and … the information sciences and their application to medicine." But Schwartz's dream of smart medical technologies, for the most part, remains just that.

Eric Topol, however, is optimistic about the future of health care. In *Deep Medicine*, he anticipates that new machine learning technologies will improve the precision and accuracy of disease diagnosis, thus providing a better way to identify the best therapies. Like Schwartz, he hopes that the time freed up by these approaches will be devoted to reviving humane medical practices.



Deep Medicine
Eric Topol
Basic Books, 2019.
393 pp.

"Artificial intelligence" initially took a very symbolic approach to replicating human reasoning. Problems were described as logic puzzles, and inference was based on rules of symbolic logic. Problems were solved by executing a sequence of steps, and natural language was addressed by building dictionaries and grammars around words and parts of speech. Even images, often reduced to line drawings, were represented by discrete elements such as vertices and line segments.

Around 1980, a small group of computer scientists proposed an alternative: What if a large number of simple computational elements modeled (very roughly) on biological neurons were to be used instead? As Geoffrey Hinton, one of those pioneers, explained in a talk at the Massachusetts Institute of Technology in 2014, we were about six orders of magnitude short of the computational power required for such a feat in 1980. Only within the past decade have we developed the hardware and algorithms needed to achieve high-performance "neural networks."

Topol describes the basics of so-called "deep" neural networks—"algorithms that permit software to train itself to perform tasks by processing multilayered networks of data"—by summarizing the kinds of problems for which these methods have been remarkably successful and reciting the litany of concerns arising from inscrutable decisions made by such networks ("baked in" biases, privacy issues, and the susceptibility of computer models to seemingly imperceptible changes to input data). "[They] still don't know exactly what features account for its success," he writes about a Stanford computer program that matches the diagnostic success rate of dermatologists.

Most AI successes so far in health care have come from the application of image-interpretation methods in domains such as radiology, pathology, dermatology, and ophthalmology. Many of these strategies are restricted, for now, to the research literature, although the U.S. Food and Drug Administration has recently approved a handful of such systems.

Techniques for assisting what Topol calls "clinicians without patterns"—medical professionals who make assessments and formulate plans by integrating heterogeneous data from a patient's records, medical literature, and talking with patients and their families—are at even earlier stages of development. These include digesting the medical literature in general internal medicine, diagnosing atrial fibrillation in cardiology, identifying the best available treatment in oncology, introducing precision robotics in surgery, and interpreting subtle cues from online communications in mental health (to which he devotes an entire chapter). Later chapters examine how AI could enhance the operations of the overall health system, aid in basic scientific discovery, and help bring nutrition and diet into consideration.

Last, Topol turns to his vision of how AI can provide a virtual medical assistant to clinicians and how these technologies can lead to the resurgence of the empathy-based care that Topol—and many others—miss in current health care. "AI can help achieve the gift of time with patients," and that extra time can develop empathy, which "is not something machines can truly simulate."

The great contribution of this book is that Topol synthesizes the fragmentary views that we who work in this field gain from day-to-day reading into a cohesive vision of a future in which medical care is about human care. Alas, achieving that depends on much more than improved technological support for clinical medicine. Hopefully, the economic and administrative forces that have done much to frustrate other recent visionaries will not derail this new plan. ■

10.1126/science.aaw4041

The reviewer is head of the Clinical Decision-Making Group, MIT Computer Science and Artificial Intelligence Laboratory (CSAIL), Massachusetts Institute of Technology, Cambridge, MA 02139, USA. Email: psz@mit.edu

Science

AI for the M.D

Peter Szolovits

Science **363** (6434), 1402.
DOI: 10.1126/science.aaw4041