78

Allegato 4

Inglese

1. Pixels in an image obtained by CT scanning are displayed in terms of relative radiodensity. The pixel itself is displayed according to the mean attenuation of the tissue(s) that it corresponds to on a scale from +3,071 (most attenuating) to −1,024 (least attenuating) on the *Hounsfield* scale. Pixel is a two dimensional unit [...]. When the CT slice thickness is also factored in, the unit is known as a Voxel, which is a three-dimensional unit. The phenomenon that one part of the detector cannot differentiate between different tissues is called the "*Partial Volume Effect*". That means that a big amount of cartilage and a thin layer of compact bone can cause the same attenuation in a voxel as hyperdense cartilage alone.

2. I'd spent my life absorbing changes in computer technology, and I knew that if I pushed through the learning curve I'd eventually be doing some pretty cool things. In 1978, when I was an eighth grader in Ohio, I built my own four-kilobyte computer from a mail-order kit, learned to program in basic, and was soon playing the arcade game Pong on our black-and-white television set. The next year, I got a an Apple II computer and eventually became the first kid in my school to turn in a computer-printed essay (and, shortly thereafter, the first to ask for an extension "because the computer ate my homework"). As my Epic *[electronic medical record software application]* training began, I expected my patience to be rewarded in the same way.

3. In mammography, too, "computer-aided detection" is becoming commonplace. Pattern-recognition software highlights suspicious areas, and radiologists review the results. But here again the recognition software typically uses a rule-based system to identify a suspicious lesion. Such programs have no built-in mechanism to learn: a machine that has seen three thousand X-rays is no wiser than one that has seen just four. These limitations became starkly evident in a 2007 study that compared the accuracy of mammography before and after the implementation of computer-aided diagnostic devices.

4. A few years ago, researchers in Brazil studied the brains of expert radiologists in order to understand how they reached their diagnoses. Were these seasoned diagnosticians applying a mental "rule book" to the images, or did they apply "pattern recognition or non-analytical reasoning"? Twenty-five such radiologists were asked to evaluate X-rays of the lung while inside MRI machines that could track the activities of their brains. (There's a marvellous series of recursions here: to diagnose diagnosis, the imagers had to be imaged.)

5. "I think that if you work as a radiologist you are like Wile E. Coyote in the cartoon," Hinton told me. "You're already over the edge of the cliff, but you haven't yet looked down. There's no ground underneath." Deep-learning systems for breast and heart imaging have already been developed commercially. "It's just completely obvious that in five years deep learning is going to do better than radiologists," he went on. "It might be ten years. I said this at a hospital. It did not go down too well." Hinton's actual words, in that hospital talk, were blunt: "They should stop training radiologists now."

6. Epic Systems Corporation, or Epic, is a privately held healthcare software company. More than ninety per cent of American hospitals have been computerized during the past decade, and more than half of Americans have their health information in the Epic system. Seventy thousand employees of Partners HealthCare—spread across twelve hospitals and hundreds of clinics in New England—were going to have to adopt the new software. I was in the first wave of implementation, along with eighteen thousand other doctors, nurses, pharmacists, lab techs, administrators, and the like.

7. A 2016 study found that physicians spent about two hours doing computer work for every hour spent face to face with a patient — whatever the brand of medical software. In the examination room, physicians devoted half of their patient time facing the screen to do electronic tasks. [...] The University of Wisconsin found that the average workday for its family physicians had grown to eleven and a half hours. [...] Something's gone terribly wrong. Doctors are among the most technology-avid people in society; computerization has simplified tasks in many industries. Yet somehow we've reached a point where people in the medical profession actively, viscerally, volubly hate their computers.

8. Telemedicine and telehealth involve a myriad of remote-health-care technologies and services collectively known as "virtual care." For years, virtual care played a minor role in the United States' $3.6-trillion health-care industry; now, with the covid-19 pandemic, millions of people are discovering its benefits and its shortcomings for the first time. If virtual care is the future of health care, is it a future that we want? In a narrow sense, the word "telemedicine" can mean the type of hardwired hospital-to-clinic setup that allows workers in a large hub hospital to assist in complex emergency procedures in distant spokes.

9. Many rural clinics and community hospitals in small American towns fear that their already meagre medical staffing, and the revenues generated from procedures that can be performed on-site, will be further hollowed out by remote medicine. And often the patients who need care the most—the old and the poor—don't have smartphones or broadband connectivity, or can't afford extra minutes on their wireless plans, placing one of telehealth's greatest promises, of allowing old people to "age in place," out of reach. Before the pandemic, outpatient telehealth across the entire Dartmouth-Hitchcock Health network averaged only thirty visits a week.

10. On a snowy day in early April, I visited the hospital's Connected Care center remotely. Mary Oseid *FaceTimed* with me while standing in the center, which is divided by a glassed-in corridor, with the tele-emergency room on one side and the tele-I.C.U. on the other. Through the glass, I could see Sadie Smith at work in the tele-emergency hub, with Kevin Curtis, an E.R. doctor and the center's medical director, next to her at a four-screen workstation. They were in the final stages of treating a patient who had suffered a cardiac arrest and been taken to one of their connected regional hospitals.

11. The tele-I.C.U. uses a software platform designed for Dartmouth-Hitchcock by Philips, the Dutch technology company. It runs predictive algorithms powered by artificial intelligence to monitor patients' prognoses. The system constantly updates each patient's "acuity score," a grade that reflects remotely gathered patient data—such as blood pressure, oxygen level, heart rhythm, and pulse—to evaluate the risk of a sudden deterioration. [...] One recent analysis suggested a correlation between equipping an I.C.U. room with telemedicine technology and a reduction in patient mortality.

12. In person, doctors often spend the first ten minutes of an appointment studying records on their computer while you sit across from them, looking at their framed degrees and family photos. But during a virtual visit the doctor meets you face to face, and her gaze mostly stays on you (or on your records on her screen—it can be hard to tell the difference). For fans of telehealth, this is one of its most appealing features. "You're looking at the physician, and the physician is looking at you," Schoenberg, the Amwell co-C.E.O., told me.

13. CT scanning has several advantages over traditional two-dimensional medical radiography. First, CT eliminates the superimposition of images of structures outside the area of interest. Second, CT scans have greater image resolution, enabling examination of finer details. CT can distinguish between tissues that differ in radiographic density by 1% or less. Third, CT scanning enables multiplanar reformatted imaging: scan data can be visualized in the transverse (or axial), coronal, or sagittal plane, depending on the diagnostic task.