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Translational Computing: What Needs the Translation?

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Systems that operate by gathering data on society and social institutions can alter their behavior in response to these data and, as a consequence, impact both society and its institutions. In this issue, we explore the challenges that are part of the projected field of translational computing.

When this month's featured article on translational computing arrived at our offices, it resonated with us as few pieces have. We regularly get articles that propose radical changes to computing and society at large. Most are speculative and romantic. They compel us to imagine a new world in which the mastery of computing processes provides the fundamental path to truth. This article is much more grounded in our time. If anything, it suggests transitions that are already underway in our field, transitions that we may not be able to control or even fully describe.

If one event sets the stage for a discussion of translational computing, it would likely be the accident involving an autonomous car in Tempe, Arizona, which occurred on 18 March 2018 and took the life of a pedestrian. That event was tragic enough for the victim and her family, but it also pointed to a growing issue for computing technology. Increasingly, we are creating products and systems that not only

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need to be tested in the public sphere but also must be developed in that sphere as well.

When your system is based on learning technology, you must deploy it in an immature state. You must put it in public use before it has fully gathered and processed all of the information that it needs to operate as a complete and mature product. If you are creating a product that does lifelong learning, if we may borrow from the educational community, you may have a system that is always changing and adjusting to the environment around it.

In an industrial society, we have long had to deal with developing new technologies that require not only public trials but also public adjustment. Perhaps the most obvious example is the field of clinical trials, which stands as a translational link between fundamental biomedical research and public medical practice. Clinical trials have many elements that look like conventional medical practice. Indeed, many a patient in need of a radical treatment has volunteered for a clinical trial with the hope of getting well. However, clinical trials are actually part of research, and they regularly produce new information about medical dosages, instructions, safety, procedures, and assessment. If medical practice begins with the dictum "first, do no harm," clinical trials start with the goal of doing as little harm as possible to get the knowledge that will allow medical practitioners to strive for that first goal of medicine.

Clinical trials are governed in a way that is quite different from more fundamental medical research. Although biomedical researchers often have to present their plans to institutional review boards, the leaders of clinical trials have to follow protocols that have been developed in public and that deeply engage the responsibilities and goals of political institutions, which are the representatives of the public. Clinical trials are one of the areas where the search for knowledge collides with the desire for public good. This collision is arbitrated by discussions and debate with people we rarely let into our research labs. These debates are rarely resolved by a careful presentation of technical ideas and a gentle agreement by political leaders. They require technical leaders who understand the needs of the public and the operation of public institutions. As two leaders argue, they must have a much broader training and experience than we currently give researching computer scientists.

If we look at the March 2018 accident in Arizona, we can quickly see that it possessed many of the hallmarks of a clinical trial and yet had not gone through any review that resembled the kind of process. The state had no process for discussing and reviewing the trials. Indeed, fewer than three weeks before the accident, the governor's office had released an executive order (AZ 2018-04) that clarified the legality of public trials of autonomous vehicles.

The executive order neither established nor implemented a process similar to that of a clinical trial. It was couched in the language of promotion, the kinds of phrases that we use to argue for the value of primary research. "Whereas the safety and mobility of all citizens is of utmost concern to the state," read one line. "Whereas the business-friendly and low-regulatory environment has led to increased investment throughout the state," read another. Building on these ideas, the executive order argued that then-current Arizona state law permitted the testing of autonomous cars on public streets provided that the cars met a few basic criteria and the testing organization filed a letter with the Arizona state government.

The order dealt with none of the issues that you might expect from a formal trial. There was no discussion of the information that the tests were designed to produce, the risks involved in the trials, or the steps that had been taken to mitigate those risks. It did not discuss how those risks would be measured, how success would be calculated, what conditions could require a termination of the tests, or the office with the authority to force a termination.

In defense of the Arizona governor's office, we can acknowledge the claim that the order treated autonomous vehicles no differently from other engineered products and that the government offices were following best practices. However, the problem is one that clearly falls into this projected field of translational computing. We are now building systems that operate by gathering data on society and social institutions. They can alter their behavior in response to these data and, as a consequence, impact both society and its institutions. The following questions then arise:

- How do we train our members to deal with these kinds of issues?
- How do we structure our field to engage the public in translational issues?

Neither question has a straightforward answer. Both will involve changes that will surprise us. Computing has undergone two or perhaps three major transformations in its short history. All were set in motion by people of good faith who believed they understood the forces that were shaping the field. All saw results that differed from their predictions.

One of these transformations is intimately connected to this magazine and the IEEE Computer Society. In 1970, the IEEE Computer Group petitioned to become a full Society of the IEEE. The petition noted that computing was "primarily an electronics engineering discipline" but that the Computer Group was having trouble keeping up with the "rapidly growing field" due to its position within the IEEE. After describing the challenges it faced in recruiting members, publications, conferences, and its relations with universities, the petition asked for elevation to the status of a Society with two conditions. First, it asked to be able to admit members who were "intimately involved with information processing technology but were not engineers." Second, it asked for a degree of independence from the IEEE, the ability to work as an independent professional society. Both requests were granted but included some constraints. Both proved to be vital as computing changed radically over the next decade.

Computing moved from its original base in electronics and mathematics to embrace a wide collection of skills. Schools started programs in computer science without any reference to mathematics. Software became the dominant point of innovation. A host of computing institutions appeared that needed the attention of the Computer Society.

The changes established in 1970 were far from permanent. In the past decade, the Computer Society has been transitioning again to respond to changes in the field, modifications in education, and reshuffling in organizational management. For its entirety, computing has viewed itself as a transformation field. We believe that we possess a lever of adequate length. All we need is a place to stand, and we shall move the university. Translational computing may be the place where we need to stand. Or, perhaps, it may point to the right place. Our vision must, of necessity, be a little dim.

This issue has other items that deserve your attention as well. In the "Virtual Roundtable" column, Rick Kuhn and his colleagues begin the process of assessing the value of the blockchain beyond its application to cybercurrencies. Philipp Hukal and his coauthors talk about using bots to manage aspects of open source projects. Cheng-Kui Huang and his coauthors discuss the business value of the Internet of Things. We also have articles on the future of cloud computing, engineering expert advice, and one clever but perhaps translational application, the tracking of household pets. **C**

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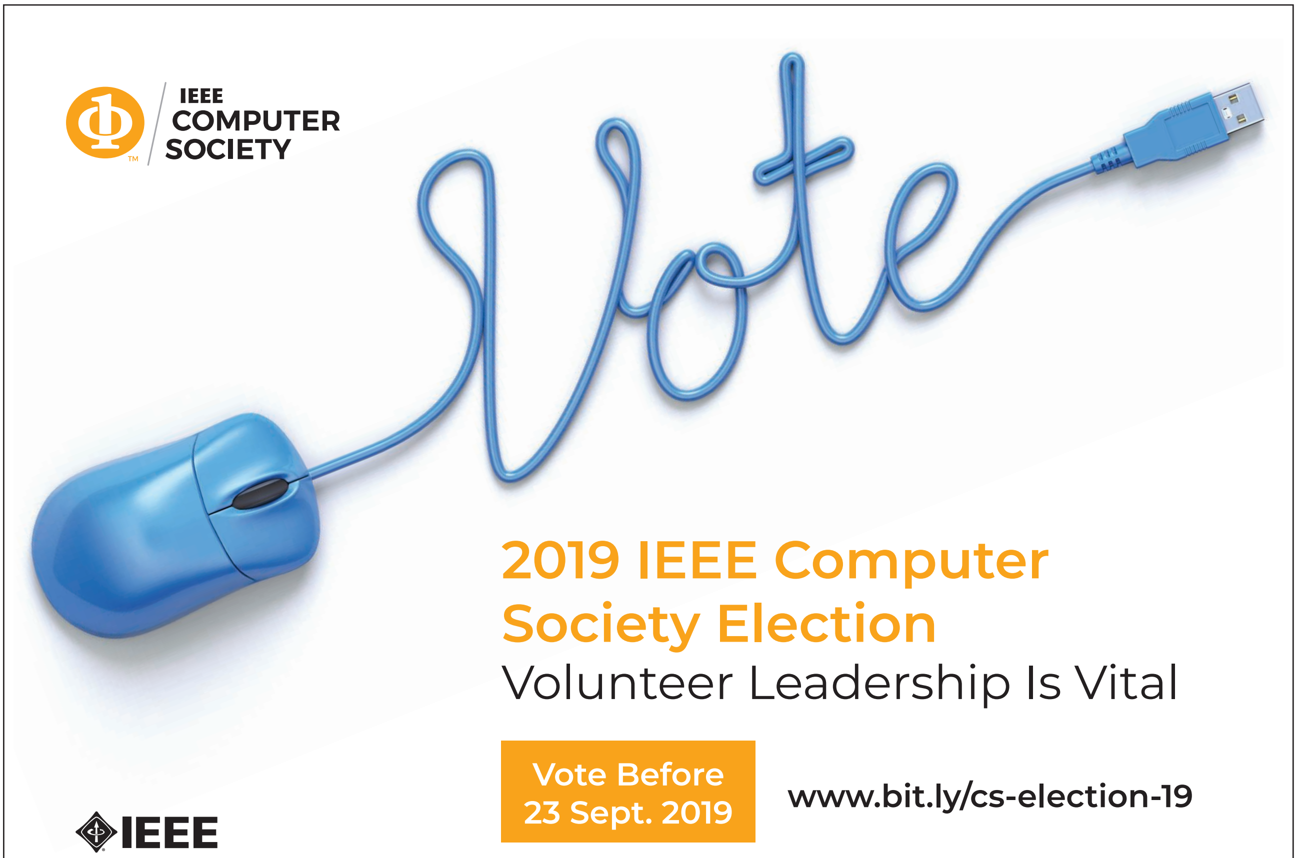

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