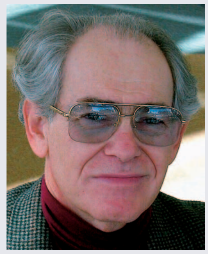
Observatoire Landau

Introductions



This is the first issue of *CiSE* in which I'm officially the news editor, so it's probably a good time to introduce myself and my function. I believe my editorial job is to work with the *CiSE* staff in deciding what topics might be good news items, what points we should emphasize in features, and what news items might be better suited as full articles (suggestions always welcome). I also get to write sidebars such as this in which I pretend to be a columnist. As a research scientist, my specialty has been computational few-body systems in particle and nuclear physics. As an educator, I now direct the undergraduate program in computational physics at Oregon State University, where I've developed five computation classes and written five books on these and related subjects. I'm active in national groups with interests in better integrating computation into education and widening the groups of people that use computation. (In fact, I just received an announcement from the US National Science Foundation entitled *CISE Pathways to Revitalized Undergraduate Computing Education*, whose focus is to establish groups that will "transform undergraduate computing education on a national scale"; www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06608.)

Although I've been working in multidisciplinary computational and physics education for two decades while also conducting basic research, it's only in the past few years that I've stopped feeling like a lone man out in the physics community. I've found kindred spirits in the computational science community, which appears to embrace multidisciplinary education more so than traditional educators do. I

mapping the right model for a given problem isn't as straightforward and could only be done by an expert. For his part, Hinton says that adapting his algorithm for different applications doesn't involve a lot of tweaking so much as changing the network's size.

Yiannis Aloimonos, a computer scientist at the University of Maryland, thinks that Hinton's work will be "quite influential," and not just because it opens the door to a variety of new, powerful learning techniques. He points to the April 2006 Columbia Theory Day conference (www.cs.columbia.edu/theory/sp06.html), where Princeton University scientist Bernard Chazelle gave a presentation on data-driven algorithm design. "In that presentation, Chazelle argued that algorithmic design as we know it has reached its limitahope that by having my feet in several camps I'll be able to provide a reasoned perspective in this space. I believe the times they are now a-changing, and the four conferences I participated in this summer appear to prove that. Here are some of my observations.

The 51st Annual Conference of the South African Institute of Physics was held in Capetown from 3–7 July 2006. Its theme was the broad relationship between physics and computers, both in showcasing the role played by computing in physics and in highlighting how physics research leads to improvements in computing. What I found particularly interesting and moving about this conference was the large number of students present and the mix of the various groups of people that constitute present-day South Africa. In fact, one of the stated reasons for focusing on how computing is changing physics education was that the students were interested in acquiring an education that equips them with the skills and confidence to use computers in problem solving, and thus find gainful employment in a developing economy in which only a few will end up as traditional physicists. In addition, I couldn't help but be awed by how the latest communication technologies has placed as distant a country as South Africa right into the heart of research being conducted with the CERN Large Hadron Collider Computing Grid and with the International Virtual Observatory Alliance's AstroGrid (with links to the South Africa Large Telescope).

Two conferences in New York also had sessions, or a major focus, on how computation affects education in the sciences and engineering. The first, the Summer Meeting of the American Association of Physics Teachers (AAPT) in Syracuse, 22–26 July, had special sessions on computation in undergraduate physics courses. These were organized by Norman Chonacky and David Winch and are reported on in detail in the September/October 2006 issue of *CiSE*. I'll only add the comment that it's nice to see the AAPT beginning to recognize the importance of computation in education after trying for years to keep computer programs out of its journals.

The second New York conference, the International Conference on Computational Science and Education in Rochester, held 7–10 August, blended computational education and research together, possibly in recognition of how important proper education is for the future growth of computational science. In contrast to the AAPT meeting, which focused on undergraduate education, here we saw examples of how computation has been introduced into K–20 classes throughout several school districts within metropolitan Rochester. This ambitious project claims that the introduction of computation within the scientific problem-solving paradigm leads to better science and math education—even for inner-city students.

The Conference on Computational Physics 2006 was held 29 August–1 September in Gyeongju, Republic of Korea. Here, too, I was struck by how important computation was in the reported research advances (in simulations involving multimillions of atoms and relativistic star systems, for example) and by the continuing reluctance of many researchers to discuss their algorithms and code verifications. But I was also struck by the large number of students in attendance (a larger fraction than at the US conferences), by their serious involvement in research, and by the interest of the researchers in the education sessions. As in South Africa, we have vibrant countries with growing economies, and computation appears to be viewed as one way to support that growth and to acquire flexibility for employment.

My conclusion? Computational science is gaining acceptance among some faculty and many students in different parts of the world. They view it as a modern way to learn science and to do research, and as a career opportunity that might provide them with employment, even if not in their specialty. Institutions and governments, in turn, appear to view computational science as a way to assist economic and intellectual development. As was pointed out at the conferences, there are now three times as many degree or focused programs in the computational sciences than there were five years ago. This is the type of good "news" that is a pleasure to report.

tions and now moves into a new phase, where as we design new algorithms, we also have access to gargantuan amounts of data. We do statistical analysis on this data, and we use the results to gain intuition for better modeling of our original problem," Aloimonos remembers.

To him, Hinton's ideas couple well with Chazelle's to form a new methodology, one in which large data sets let researchers map relationships among relevant variables. "We let the data itself tell us how things are related," he says. "Of course, the data cannot tell us everything—we still need to do some modeling, but now our modeling will be guided by the statistical analysis. In this new era, Hinton's deep autoencoders and dimensionality reducers will become a basic tool for anyone developing new algorithms."

In his own work with Kwabena Boahen of Stanford University, Aloimonos designs chips that he hopes will one day integrate computer vision, hearing, and language capabilities into one cognitive system. It's a difficult enterprise, one that is tied to our understanding of how those capabilities are entwined in the human brain.

Open Box

Hinton's strategy harkens back to the very early days of neural networks—the 1950s—when people wanted to train one neural layer at a time. His *Science* paper marks the first time anyone has penetrated the black box to show that this can indeed be done, even for very deep networks. Encoding and decoding a complex image such as a human face is an important