Quantum computing: Finding solutions by the people for the people

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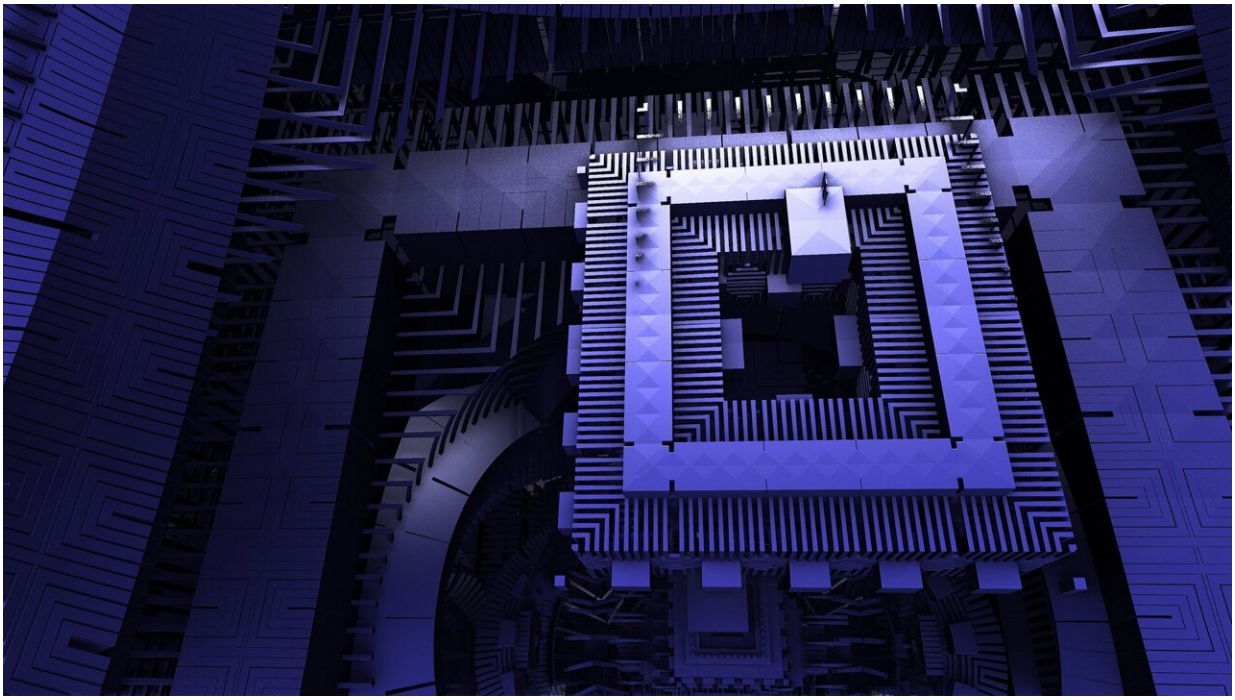

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PEARC24 launched its first Workshop on Broadly Accessible Quantum Computing (QC) as the full conference began, July 22, in Providence, RI. Led by NCSA's Bruno Abreu and QuEra's Tomasso Macri, 30+ participants included quantum chemists, system administrators, software developers, research computing facilitators, students and others looking to better understand the current status and the prospects of QC and its

applications.

The workshop focused on how integrating quantum technologies into traditional research computing programs and facilities can benefit the broader community.

"There is a consensus that quantum computers will be very specialized machines that will deliver several flavors of advantages for specific computational problems," said Abreu.

"Overall, it's impossible to imagine an application solving a problem with substantial scientific and societal impact that runs entirely in a quantum computer. The much more likely scenario is one in which we have hybrid applications that leverage quantum information processing in tandem with conventional computing resources such as CPUs, GPUs, FPGAs, and parallel file systems.

"Thus, connecting the advanced cyber infrastructure and the QC communities is a critical effort to the progress of QC and HPC. Starting to bridge the gap is what we wanted to get out of this workshop, and PEARC is a great platform for making this happen."

Through panel discussions as well as case studies, the workshop centered around how to make QC more accessible. Kicking off the workshop, Keynote speaker Yipeng Huang, assistant professor of computer science at Rutgers University, explained the current state of quantum computing and how some potential applications, such as factoring and search optimization, could benefit finance, industrial and logistics sectors.

However, among the issues quantum computing presents is that quantum states are fragile and susceptible to several types of noise. Error correction codes to address that noise can be quite expensive and require conventional computing in tandem with quantum information

processing.

Though simulation will continue to play a crucial and growing role as quantum computing systems scale into the era of quantum error correction, researchers will need access to more powerful simulation tools.

So how will we continue to make progress, given quantum is very much a problem if you don't know what you don't know? In a word, people.

Huang spoke about the work Rutgers has done in considering workforce development in QC, including his creation of a quantum-focused curriculum. However, he said, there are very few QC programs outside of R1 institutions. Beyond that issue, Huang said growing a strong quantum computing workforce really requires engagement at the early grade school level, all the way through graduate school.

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The conversation shifted to energy consumption in a panel discussion focused on the transformative power of quantum technologies. Panelist Nicholas Harrigan of NVIDIA noted that a quantum computer will have to have a supercomputer running alongside it and that NVIDIA's runs the most energy-efficient supercomputers in the world.

Fellow panelist Travis Scholten from IBM observed that assessing the usefulness of quantum computers based solely on single-number metrics (such as energy consumption) alone is premature, quipping that "Quantum advantage is in the eye of the beholder," and pointing out that in current computational workflows, tradeoffs are always made about speed, accuracy, energy and a myriad of other factors.

Harrigan agreed, saying you must measure the impact versus the cost,

such as energy consumption. For example, he said quantum is better at computing-intense problems than data-intense problems, so the devices should be seen as hugely impactful innovation tools, rather than widespread data processing centers.

Rounding back to the importance of people in advancing quantum computing, Harrigan and Scholten both agreed that partnerships will be critical; for example, QC developers aren't going to understand what a specific domain needs without partnering.

The final panel discussion of the day asked, "What Do We Need to Make Quantum Resources Useful and Broadly Accessible?" Again, the answer seemed to essentially be "people."

Erik Garcell from Classiq said the more people who have access to quantum computing, the more useful it will be. Fellow panelist and QuEra Co-founder Nate Gemelke added, "The ultimate software is people," saying accelerating education in quantum is the real challenge. He said it's hard to pinpoint how far out "useful and broad access" is—it could be five years, it could be 25 years. But clearly, acclimating people to quantum computing is key to progress.

Gemelke said there may be too much of a bias in thinking about how classical computing has been developed that it's stifling development of quantum computing, adding the need to bring new thinkers in to "play" in the space without worrying about the cost or immediate results.

Garcell concurred, noting quantum is a scary concept for a lot of people and we need to make it friendlier, particularly for young students. Gemelke echoed the idea of starting students early in QC, even citing the book "Quantum Computing for Babies" (Sourcebooks Explore), saying if you can teach the youngest mind what a quantum bit is, they may be able to come at these challenges in a different way.

"Quantum is an important experiment for humanity," Gemelke said. "I believe we will all be humbled by what we achieve."

Abreu concluded by saying that while gauging the appropriate content and audience for a first workshop iteration is always challenging, the organizers were pleased to see such an engaged group of people who not only were interested in learning about QC through the many sessions throughout the day but also contributed with thoughtful comments and questions.

"I think we had an excellent balance of academic and industry folks, which resonates with the overall theme of making QC accessible since, as pointed out during the workshop, collaboration is critical," he said.

"The feedback we received was quite positive and we are very much looking forward to organizing this again for PEARC25. The QC landscape evolves at a very quick pace, and we are confident much progress will unfold to make the next iteration full of new content. We will definitely need a bigger room."

More information: Learn more about NCSA's work in this quantum computing here.

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