Episode 2: Quantum Insights: Navigating Tomorrow's Tech Landscape

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Welcome to the podcast series by the HCLTech Enterprise Technology Office, exploring the trends in emerging technologies.

Pranav Kaushal: Hi everyone. Good morning, good afternoon, good evening. I am Pranav Kaushal, Strategist, Open Innovation, Office of CTO at HCLTech. I welcome you all to HCLTech's Enterprise Technology Office podcast. This podcast is focusing on quantum technologies and the role that they have to play in our future. This podcast is focused on how quantum ML is paving the way for the next-gen tech revolution. I am joined by Dr. Venkat Subramaniam from IBM, Sanjay Muthiyalu and Abhinav Khare from HCLTech. So, we have covered the different variations that are happening from classical to quantum ML space. Let's also try and understand a little bit about the challenges. I think we have covered it from a high-level perspective in the last section, but quantum volume is something that is of utmost importance when we are talking about adoption and practical applications. So, Abhinav, how would quantum volume affect the efficiency of quantum ML algorithms?

Abhinav Khare: Well, see, Dr. Venkat talked about, you know, what are mitigation approaches? So there's something that we all know: the hardware is sort of going under evolution. And then, if you look back, it's part of the journey, right? Evolution journey. And there will always be requirements for evolution always. But thankfully and then that's been sort of nature, we have these mitigation approaches to better utilize the hardware. But the perspective of the quantum volume is basically to, let's put it that way; maybe you can use this unit of measurement to quantify the noise level in the quantum hardware. And then, based on that, you can decide if you're talking about problems, the hard problems, as we discussed early in the discussion. And even in the hard problems, is the hardware ready for that hard problem? Or selecting the right hard problem? in the potential application. So, this is sort of a unit that indicates the viability of solving those problems. So, in technical terms, quantum volume depends on the number of qubits and the noise in the hardware. So, these two are the parameters that it sort of undertakes. Quantum volume is sort of inversely proportional to noise. So if a quantum volume is low, then there is more noise. So, if you need to achieve accuracy and have an optimal solution for quantum machine learning algorithms, then the quantum volume should be higher. As I said, it's always evolving. We're trying to reduce the noise.

IBM has been really active in this space. As far as I recall, the initial IBM Falcon, I think Falcon's quantum volume was four. Dr. Venkat, do correct me if I go wrong somewhere. But I think the latest result shows that the quantum volume that IBM can offer is 512 in the Falcon R, R10 machine. And really, IBM has really come a long way. And then we had interim IBM Osprey, which is fairly larger. And you know. The examples Dr. Venkat has been bringing about, you know, most of these systems, they are only some of the systems that are publicly available and some systems are still under research and there's a lot of research work going on. So, but, you know, that's what I wanted to bring forward. You know, it's a unit, a quantum volume is a unit, which potentially, you know, we can look at in terms of selecting the applications and use cases when we move towards sort of our adoption journey and trying to build models in quantum machine learning. I hope that helps.

Pranav Kaushal: Thanks, everyone. Dr. Venkat, would you like to add a couple of points from your side toward this quantum volume aspect as well?

Dr. Venkat: Yeah, certainly. So, just like there is Moore's law, which says that the power of classical computers doubles every two years, right? Similarly, if you look at it, quantum volume has been doubling every year in fact. So, it is an equivalent measure to Moore's law in the quantum computing world and as I have mentioned, it has been growing and it is a measure of how usable your qubits are because you can keep on increasing your qubits, but if they are not usable in your computation, they are of no use. So, quantum volume is that measure that tells you that you have n qubits, but how well can you use it? How many of them can you use to build your circuit?

Pranav Kaushal: So, just an addition or, let's say, the next step towards this domain, In light of the noise and NISQ era that we just discussed, the concept of quantum volume is still developing. Ongoing research is examining how well we can actually use it, which suggests that we may not be able to fully transition to quantum computing for at least a few years to come. A hybrid approach, which is a combination of classical and quantum, is something that is trending and that is kind of going mainstream into adoption also. So, Dr. Venkat how do you think this hybrid approach can benefit in solving the real industrial problems?

Dr. Venkat: So, first of all, I think it's important to understand that quantum and classical already work together right and they will for the foreseeable future. Today, how do we access quantum computers? We access it over the classical network. We program using the same classical tools like Pythonic languages like Qiskit. So, there is already an interplay that has begun and which is happening and which is enabling us to use this technology. And so, the next wave of quantum that you know IBM will deliver this year is the IBM quantum system 2. What is System 2? System 2 puts us on a track toward a large quantum. IBM has said that we will have this 100,000 qubits quantum-centric supercomputer, and what is this supercomputer? It is really a modular architecture that enables scale; it combines quantum communication and quantum computation to increase the system capacity and then uses hybrid to

integrate quantum and classical workflows seamlessly. So, at least for the next 10 years as we see it, the future is certainly this hybrid approach where quantum and classical work together.

Pranav Kaushal: Thanks Dr. Venkat. I think we have talked a lot about the technology aspects of it, the challenges and the market trends and the journey. You mentioned, Dr. Venkat, that education is something that is really important in this domain of quantum as a whole. So Sanjay, from a resource and skill standpoint, what are the requirements to develop a quantum ML based application?

Ravikumar Sanjay Muthiyalu: Based on our research and ongoing training that we're conducting to incubate a new breed of quantum-ready data scientists and machine learning engineers, we've seen that there are multiple technologies that come into play to deliver enterprise-ready quantum applications. And this is a rapidly evolving area. But what I have concluded is that there are three layers of competencies. At level 1, you need to have a very good understanding of basic quantum mechanics, linear algebra and probability and these form the kind of theoretical base, for you to even understand the kind of domain that we are getting into. Now, building upon this base at level 2, traditional data modeling and data science concepts are essential, with an understanding of how data structures, you know, differ in the quantum world. So, this will give you a good theoretical and a kind of a domain base. At level 3, in terms of tooling, now we need to have a decent level of proficiency in languages like Python. Python being the most important for many of these data science applications. Now quantum. potential quantum data scientists and machine learning engineers also need to be trained on quantum cloud service offerings from partners such as IBM and other cloud vendors and, more importantly, the respective quantum libraries.

I think Dr. Venkat mentioned a lot about Qiskit from IBM. So, in understanding of our Python, it's also a good appreciation of these libraries that is very important from IBM as well as the other cloud providers. Now, over and above this foundational hardware, the different approaches to, it's also good while it's not essential, it's also good to understand what are the different foundational approaches to quantum computers that are going on, such as superconductors, ion trap devices, linear and non-linear photonics-based systems and so on and so forth. This is largely from an advisory perspective where we go on as an advisor and the customer wants to understand an end-to-end journey. Finally, we are also tracking niche startups that are trying to solve specific problems in the value chain across. So again, based on all of this, we have kind of created a three-month training program and our first batch of quantum-enabled machine learning consultants are being trained. We will probably have some quick updates on that soon, but it's very exciting. Again, the challenge is that, as I said, it is not a simple question of picking up a particular language and coding. It also needs a lot of theoretical knowledge combined with some mathematical knowledge that needs to be infused. I hope that answers your question.

Pranav Kaushal: Thanks for covering that. Abhinav, you kind of talked about the academy part during the initial bit of the session and people really need to start working on upskilling themselves and it's kind of becoming an enterprise responsibility to get the employees trained on future technologies. So how is HCLTech developing the quantum workforce within the ecosystem, within the organization?

Abhinav Khare: Yeah, correct. I think some bit, Sanjay also mentioned in the last comment. We are working with his team to enable the sort of next wave of quantum enabled data scientists. And the journey started with the foundations and we are doing that. So, similar initiatives are happening. across the organization we've been engaged under the academy. Ever since we started, I think we've inspired and touched upon the Quantum Foundations to almost 500 to 700 HCLTech employees. And then that sort of becomes our base. And then early... an infusion of technology was given, which inspired this bunch and then the way we are able to operate the fluidic lab is that we keep on running these training and enablement programs. And then we sort of find quantum champions inside the organization. And then they become part of our sort of labs. And then, we keep them engaged in such initiatives as customizing initiatives, consulting engagements, or internal incubation initiatives. So, we've been doing this. We've been like any academic initiatives; we have internal batches and try to sort of certify them. And then there's this sort of big push on the IBM Qiskit SDK. And then, as in, like, when we started with the awareness and that's something we saw some bit of affinity in the developer community that we had. And so, we ran a dedicated batch on the IBM technologies and SDKs. We've gone to an extent where we've got the first lot of skilled professionals certified on IBM technologies and they've achieved their certifications also.

I think we started the batch with 30 and out of them completed their training and the whole learning modules and five of them have cleared their certifications also. So, a lot of such initiatives are happening. A lot of structured programs that we have. As I mentioned before, one is dedicated to quantum machine learning, the batches on quantum foundation. And of course, as Dr. Venkat also said and he alluded to the need for, it's not just about the technology and understanding the business side of it. And then, even analyzing it, we discussed whether using a quantum infrastructure for a specific problem makes business sense. which problem, if it is qualified to be used, does it really make sense to solve it using quantum computers? So we do sort of business enablement exercises also, a lot of brainstorming activities that we do. We engage with the sales community also. We're also putting a dedicated foot forward in terms of how an account manager has his first quantum discussion or quantum technology discussion with the customer. How does he bring forward a use case into his discussion? So we're creating content, inspire readouts that he can, the account managers and sales folks can really read, equip themselves with right conversation content. Then, after the content, to start the engagement, interaction and potential opportunity identification. they have this repository to bank upon and send points of view and readouts. And so we're trying to cover all our bases to be ready for this future wave. We've got technology enablement in place. We are actively doing it. There is a business side to it. And then, as I said before, we're trying to do a lot of similar thought leadership initiatives that we are trying to not only help our employee based but also help, we keep on doing some similar discussions with our customers also, so you know we can impact their organization and in fact few of our customers have gone to next end of the discussion that can we carve out a training program for their sort of dream team for quantum and what are the elements that they would need. strike collaboration with academic organizations also, a joint program, an email program, so all sorts of things. We are trying a bit to cover all bases as I said.

Pranav Kaushal: Thanks Abhinav. I think HCLTech covers all bases regarding ecosystem collaborations and leveraging our ecosystem partners from various dimensions. So our last section of this discussion. We have talked a lot about patterns versus noise, the importance of education for this technology to advance, the development of quantum versions of classical ML algorithms and the importance of upscaling the workforce who will make this technology happen in the coming future. So. As we wrap up this podcast session, I would love to get a few closing comments from everyone and a sneak peek into their road maps in their respective domains around quantum ML. So probably, I will start with Dr. Venkat.

Dr. Venkat: Thank you, Pranav. So, as our team continues to research in this space, we have prioritized delivering rigorously proven quantum advantages with robust speed-ups. And while we make this effort, we are also making an effort to present our results in a widely accessible way to the community, because I think this is an area where we all need to work together to make good progress. And then, as Abhinav and Sanjay also mentioned and as you are doing in HCLTech, skilling, preparing a workforce and then working with customers are really the important aspects that allow you to ground the effort that you are putting into this. The good thing is that the entry barrier is so low because you can just start using Python libraries like Qiskit and start implementing. So today, you know most of the coding community knows Python. So it's very easy to just use like you're using some machine learning or data science libraries, you can start using the QML libraries, so it's not even hard for anyone to try and see and get results and this is also the perfect time to explore quantum computing because especially in IBM we are very excited after the quantum utility paper where we showed that there is a point where quantum computers could serve as a scientific tool to explore new scale of problems which classical may not be able to solve right. So we have the machines today, we have this easy access. I think it's time for all of us to explore this and see what is possible. And I think the road ahead is very, very exciting. Thank you.

Pranav Kaushal: Absolutely. Thanks, Dr. Venkat. Sanjay?

Ravikumar Sanjay Muthiyalu: Thank you. Now, as... Dr. Venkat and Abhinav are talking about there's a significant amount of interest in this space. Now it's my observation that there are two sets of customers, some potential customers rather. There is one set of customers who think, hey, look, this is a nascent technology, I'll probably sit and wait for a couple of years to see what development happens. On the other side and I'll probably see a larger... superset of customers are actually looking at it this way. Hey look, the technology has got such potential to create a game changer for my business that I would rather invest right now rather than be a bystander. So, in that aspect, there is a tremendous and significant amount of investment that we're seeing in this space across funding for startups, academic research, enterprise-level innovation, etc. But what is emerging is the biggest barrier to adoption is actually the talent gap. This is a space where the digital business service plans to step up and not only fill the talent gap by building high-caliber QML consulting capabilities, but we're also looking at methods and techniques to accelerate the adoption because that is also important.

For example, again, these are early days, but we're looking at areas across the friction points, in the solution development cycle to see how we can build some accelerators, points, you know, some kind of scripts, automation techniques, etc., where we cannot just deliver consulting capabilities, but also bring together, you know, a bag of tools which can accelerate this, you know and enable customers to rapidly experiment. So again, this is an area which I'm very excited about. Finally, I would like to wrap up by saying that as quantum computing becomes more and more accessible, we do not need to look at futuristic scenarios, but also at some problems that can be solved today. You know, for example, there are quantum-inspired algorithms, etc. I'll stop at that and hope that kind of gives you an idea of where we are looking in the future.

Pranav Kaushal: Thanks, thanks Sanjay.

Abhinav Khare: Yeah, I'm really glad we had this wonderful panel and then we had this discussion. I learned a lot from each panel member today and I'm glad we had this conversation and looking forward to similar conversations in the near future. I mean, as closing comments, at HCLTech Quantum Lab, we At least sort of agreed that enablement and identification and application, being intelligent about it is the key element and then, of course, something that came across is maybe as an organization, we are checking the right boxes. we are doing the right thing. So that's a takeaway for me in this conversation today. And you know, I mean, it's time where we've done quite a bit of exploration. And Dr. Venkat also said a lot of research that's... the sneering completion, a lot of research which is completed. And I think we're near to the time frame where we will see some real action soon. And every small element that HCLTech Quantum Lab has undertaken as an exploration initiative, as simple as getting the first wave of quantum ML data scientists and consultants that the lab has enabled along with the... Sanjay, we really like to see that team in action and how we can help our customers. And similarly, as I said, ecosystem collaboration is a key element. I look forward to how this ecosystem will become a stronger force and really start to make things happen in this space. So, I think I'm really excited about the work we all do as an ecosystem. partners are doing and I am excited to look at the future potential and engagements and the fantastic work this technology has to offer. See some of that in action. So yeah, with that, I would like to close my thoughts today.

Pranav Kaushal: Thanks, Abhinav and everyone. I really appreciate all of your time and support in making this happen and kind of bringing in intriguing insights from different dimensions with respect to quantum ML. Thank you everyone.