

Transcript | An Introduction to Quantum Computing for Policymakers

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00:00:10.420 --> 00:00:11.560

Leonardo Quattrucci: All right.

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00:00:12.250 --> 00:00:22.519

Leonardo Quattrucci: good afternoon, everyone, or good morning, or good evening, depending on where you're calling from. Happy World quantum day, on the international year of quantum.

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00:00:22.750 --> 00:00:50.540

Leonardo Quattrucci: I never thought we would get here. In fact, I was working in a quantum team just a few years ago, and it seemed like we were just getting out of the cave. And now we have an international year of quantum and more. So we're delighted to welcome you to this introduction to quantum computing, hosted by apolitical. My name is Leonardo Quattrucci. I am a senior advisor here at Apolitical, and I'm delighted to moderate this conversation.

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00:00:50.910 --> 00:01:15.547

Leonardo Quattrucci: for those of you who are joining us for the 1st time. Perhaps a political is really where governments and civil servants come to learn right. We have a quarter 1 million people joining this community from 170 countries, and the mission is to make government smarter. And the way we do that is

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Leonardo Quattrucci: to, you know. Create events like this.

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00:01:21.130 --> 00:01:40.831

Leonardo Quattrucci: well, I see already. Thrilling activities in the chat. Please keep it coming. There'll be there will, this event will be recorded on demand. So please, no need to record it yourself. Let us know whether you're online where you're calling from and

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00:01:41.260 --> 00:02:09.399

Leonardo Quattrucci: what you do because we want you to be part of this community. I see here we go from Nova Scotia to Brindisi, Amsterdam, Peterborough, Uk. Great, because I mean

world quantum day is the launch of a very special initiative. Here at Apolitical is the quantum community of practice that we hope you will join. As part of this event.

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00:02:09.590 --> 00:02:37.220

Leonardo Quattrucci: the link will appear in the chat, and so, as you go in to introduce yourself, please don't forget to open it in your browser and join this community because this is just an episode that is launching a trend. Right? And the trend is the conversation around. What do we do? How do we manage to move from theory to reality when it comes to quantum technologies? Right? I was just reading an essay that calls that says that quantum is

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00:02:37.811 --> 00:02:51.298

Leonardo Quattrucci: loudly overhyped, but also quietly undersold. So it's a complex process to to manage and it will take all of us.

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00:02:52.410 --> 00:03:02.959

Leonardo Quattrucci: so please navigate to the bottom of the chat, join through the link. My colleagues will post the same link later on as well.

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00:03:03.433 --> 00:03:30.189

Leonardo Quattrucci: As I said, this is a I'm just gonna repeat it for those joining us. Now, this is a recorded on demand events. You can see it on a political website, so no need to record it yourself. We do want you, however, to be active in asking questions. I do see a flow of activity growing, in fact. So I don't think this this audience will be shy, which is one of the problems we haven't solved

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00:03:30.684 --> 00:03:40.079

Leonardo Quattrucci: with technology yet. The shyness of audiences, anyway. So, surfing on your enthusiasm, I'd ask you to join

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00:03:40.270 --> 00:04:05.770

Leonardo Quattrucci: a poll, and the link will be posted in the chat, and the question of the poll is, how would you rate your current understanding of quantum computing? In fact, there's a screen popping up now. So is it, you know. Is it Black magic, or you feel informed, and you you already know enough to

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00:04:06.670 --> 00:04:12.610

Leonardo Quattrucci: to engage in an intelligent conversation about the topic. Please let us know

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00:04:14.630 --> 00:04:21.800

Leonardo Quattrucci: I cannot vote. Unfortunately. Okay, the majority of it is, I've heard it, but don't understand it.

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00:04:22.180 --> 00:04:38.959

Leonardo Quattrucci: So it seems like it's becoming one of those conversations that happen in corridors, and that we feel like are growing in importance, but we are not yet equipped to engage with it to set a direction. So here comes the second poll.

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00:04:39.280 --> 00:04:45.520

Leonardo Quattrucci: which is what do you see as the biggest barrier to government engaging in quantum computing

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00:04:45.760 --> 00:04:52.430

Leonardo Quattrucci: quantum technologies? More broadly. Is it understanding. Is it expertise? Is it uncertainty?

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00:04:54.650 --> 00:05:04.369

Leonardo Quattrucci: Boat boat complexity? That's another word that is growing in use?

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Leonardo Quattrucci: This is hmm.

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00:05:12.140 --> 00:05:13.200

Leonardo Quattrucci: Okay.

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00:05:15.500 --> 00:05:24.479

Leonardo Quattrucci: alright. This is a little bit more mixed. But the the price goes to lack of internal expertise.

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00:05:26.120 --> 00:05:27.949

Leonardo Quattrucci: Followed by

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00:05:28.140 --> 00:05:39.419

Leonardo Quattrucci: almost an equal number of people devoted for complexity and technical language and competing priorities and limited resources. So, on the one hand, we feel unequipped to

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00:05:39.430 --> 00:06:00.699

Leonardo Quattrucci: to manage the issue. But the issue is intrinsically complex, plus, we have a lot of other complex issues to deal with. But hopefully, today we'll give you more tools to tackle this conversation, and in fact, it won't be me giving them to you. But, in fact, it would be Kate Webber who is the head of governance and external affairs at Google Quantum AI.

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00:06:00.700 --> 00:06:11.630

Leonardo Quattrucci: Where she leads engagement with governments to shape what governance of quantum will look like, and should look like. Thanks, Kate, for joining us.

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Leonardo Quattrucci: Frankie Hyman, who co-founded and led quantum Delta in the Netherlands, which is a pioneering initiative. I'm biased because I work with them, and now consults a host of organizations from startups to NATO on quantum specifically, but deep tech generally.

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00:06:27.950 --> 00:06:37.920

Leonardo Quattrucci: And Tom Tom Scott, who is actually part of a quantum office in the UK department for science technology and innovation.

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00:06:38.421 --> 00:06:44.929

Leonardo Quattrucci: So the UK follows its tradition of anticipating trends and setting up offices. Thanks, Tom, for joining us.

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00:06:45.435 --> 00:06:55.829

Leonardo Quattrucci: You. You know these are just snippets of the expertise of the speakers. I'm not doing them justice, but you can read more about them in the speaker, tab in the top right?

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00:06:56.320 --> 00:07:05.960

Leonardo Quattrucci: And so, just to spice it up. Tom. Frika, Kate, I want to come to you and ask you, can you think about a metaphor

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00:07:06.150 --> 00:07:10.530

Leonardo Quattrucci: through which you would explain quantum computing to a 10 year old.

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Leonardo Quattrucci: or to me, which is pretty much the same level. So so give it a thought, and then I'll I'll come to you

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Leonardo Quattrucci: and the audience could take this moment to join

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00:07:25.190 --> 00:07:36.799

Leonardo Quattrucci: the community and share your answer, like, what's the metaphor that you would use to explain quantum technologies and quantum computing specifically to a 10 year old, or me,

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00:07:38.680 --> 00:07:45.119

Leonardo Quattrucci: okay. So Kate, do you want to get us started?

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00:07:45.820 --> 00:08:05.080

Kate Weber: Sure I can go first. I was kind of looking for some inspiration here, so full disclosure this wasn't. I did not come up with this metaphor, but I really liked it. So the one that I'd like to put forward is, imagine you have a problem. You dropped an object into a pond.

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00:08:05.430 --> 00:08:07.459

Kate Weber: and you've got to find it.

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00:08:07.720 --> 00:08:18.269

Kate Weber: And if you were to use a classical computer to try to find this object, you might take a stick and start poking it around the pond until you can feel it. Let's imagine it's a pretty large object

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00:08:18.580 --> 00:08:29.010

Kate Weber: with a quantum computer. You would instead throw a stone and study the pattern of the ripples and kind of look from those to try to figure out where the object is.

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00:08:29.060 --> 00:08:56.060

Kate Weber: And so the key points. From this. I want to make our quantum computers. They are using different kinds of information to solve problems, and that means they will be useful to solve certain kinds of problems right? This wouldn't work as well in this particular metaphor. If you know you dropped your object into something that was like much more solid than a pond, right? A pit of foam or something right? It matters kind of the characteristics of the problem.

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00:08:56.524 --> 00:09:08.200

Kate Weber: And and so it's not that we will replace classical computers with quantum computers, but they will be very useful to help us access problems that we cannot solve with classical computers.

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Leonardo Quattrucci: Okay, so stick versus the pattern of the waves to complement what we can do today. Thanks, Kate Freika. You want to go next.

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00:09:19.430 --> 00:09:30.109

Freeke Heijman: Yes, thanks. And Hi from Riyadh. So it's world quantum day. So I'm here in Saudi Arabia for an event of the world. Economic forum.

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Freeke Heijman: yeah. So what I would like to bring forward is to get the concept of the observer. So that's a foundational concept within quantum mechanics that as an observer you identify or you create reality in a way, so my metaphor would be. There's a magic bull, and

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Freeke Heijman: that magic bull changes colors, depending on who's watching it. So if Daddy is watching it, it's gonna turn yellow. If I am watching it, it's gonna turn blue. If you are, gonna watch it. It's gonna turn pink. So yeah, this idea of an observer. yeah, creating the reality.

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00:10:15.020 --> 00:10:36.699

Leonardo Quattrucci: Okay, okay. I, as you were speaking about observer reality. I was reading a metaphor in the notes here that talks about a library when no one is aware of the alphabets. It

made me think both of you made me think of Jorge Luis Vorges and his his stories, but we'll get it to to Tom. What's your metaphor, Tom?

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Tom Scott: Thanks, Leonardo. I'm going to use a metaphor to try and explain superposition, which is one of the principles of quantum mechanics. So if you think of a regular classical computer

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Tom Scott: as a coin, and you flip a coin, and it's either a head or a tail, and that's the sort of the coding for for classical computing a quantum computer. If you flip a coin

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Tom Scott: and the coin is still in midair, and it can be one or 0.

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Tom Scott: That essentially is due to the property called superposition. And if you can harness superposition within a corner computer, you can fundamentally compute information in a different way.

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00:11:24.070 --> 00:11:24.690

Leonardo Quattrucci: No right, so.

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Kate Weber: Oh, sorry. Just a plug as well. If you go to today's Google, Doodle is also trying to illustrate this concept. So encourage everybody to take a look at that afterwards.

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Leonardo Quattrucci: Yeah, and and share resources along this line. I see that some are sharing articles where they use metaphors. Their Google resources

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00:11:44.890 --> 00:12:11.690

Leonardo Quattrucci: post them in the community as well, so that we can create a library going back to the library where we actually shape an alphabet to talk about this issues in government. Okay? So let's get, let's get to it, Tom. I want to restart with you and begin a little bit with the

basics. What exactly is quantum computing, is it? Is it a male? And why is there an office dedicated to this in the UK Government? Now.

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Tom Scott: Yeah. So so, caveat, that I'm not a technical specialist. But I do work with lots of experts in the field. Quantum computing is a new type of computing. It's a new paradigm

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Tom Scott: that harnesses quantum physics and the properties of quantum physics. So that is how the world works at an atomic and subatomic level. So thinking about harnessing the behavior of electrons and photons to process information in fundamentally new ways.

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00:12:46.450 --> 00:12:47.510

Tom Scott: this is

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Tom Scott: has the potential to be game changing both from economic perspective and a security perspective as well.

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Tom Scott: but I think Kate made this point as well like it's not going to replace digital like corner computers are only in classical computing. Corner computers are good at certain types of problems. So things like optimization simulation materials modeling, there are specific problems that quantum computers have the potential to outcompete

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Tom Scott: classical computers. In. In the UK. We published our national quantum strategy in 2023, and the office of quantum. So that's the team that I'm in was set up to deliver on that. So the UK has

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00:13:29.850 --> 00:13:53.540

Tom Scott: a sort of world leading ecosystem in quantum, both in quantum computing and in other quantum technologies as well. And the office has been set up to basically realize the opportunity of quantum in the UK. So quantum will be a massive driver of productivity across the UK industry sectors, and we want to make sure that the UK can be an early mover and early adopter of this technology.

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00:13:54.990 --> 00:14:10.550

Leonardo Quattrucci: Are these the same reasons why a you set up quantum delta and and why you are now in Saudi Arabia, I mean, there were a few of these initiatives when I started working on this 5 years ago, and now it seems like it's widespread.

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Freeke Heijman: Yes, exactly. It has to do with the tremendous promise that this technology holds, and it has been

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Freeke Heijman: in the scientific labs for well over decades, but the past decade, it has really made a great acceleration. So this is also the reason why governments they know we have to invest in this. We have to take note of this

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Freeke Heijman: because it has all kinds of strategic implications, because, as Tom was saying, it's really a paradigm shift. It's not just a faster computer. But it's a computer that really can do things that classical computers cannot do because it computes

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Freeke Heijman: in a way that nature does like molecules, atoms the way they behave. It's quantum mechanically. And a classical computer just cannot have these superposition and this entanglement, the things we discussed in the metaphors.

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Freeke Heijman: So. And all these strategic applications it's gonna have is also reason for governments to engage. And

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Freeke Heijman: that's different than when it was only in the scientific labs. Because then you throw funding at it via your national scientific organizations. But when it becomes a strategic technology, you really have to make

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Freeke Heijman: dedicated policies as well. And that's yeah. When already, 10 years ago, in the Dutch Government, I was a policy person, too, we started to invest and also to engage and and see how we could. Yeah, accelerate technology and also collaborate on the international.

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00:15:58.199 --> 00:16:14.080

Leonardo Quattrucci: Okay, I, I come to you because you're sort of have that role and you're in between governments on the one hand and on the other hand, Google, which is a pioneer in the field, I mean building some of the most capable machines. What are some of the real world applications that

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Leonardo Quattrucci: people joining the events and governments more generally should be paying attention to.

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Kate Weber: Yeah.

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Kate Weber: Yeah. So Frika kind of alluded to this a bit. So 1st of all, I will say, you know, there are lots of there are interesting experiments we can do on today's quantum computers. There are not real world applications that are impossible on a classical computer. Yet. So really, what we're aiming for is these applications that are possible on a quantum computer and not possible on a classical computer.

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Kate Weber: So far, we've shown, we at Google and others have shown, you can use a quantum computer to do a benchmark calculation. So a calculation that does not have real world use. That's not possible on the classical computers, but not something

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00:17:00.360 --> 00:17:28.239

Kate Weber: that's actually useful. But we do believe we will see the 1st of these useful, real world applications that are not possible on classical computers in the next few years in the next 5 years is kind of what Google has said, and then widespread adoption, I think, is another question like this isn't going to be an on and off switch. It's going to take some time to get to widespread adoption and to get to the point where we have many, many applications

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Kate Weber: that are beyond classical. What will those be? Frika noted? We expect some of the 1st real world applications to be related to molecular simulation. So, as she said.

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Kate Weber: and there's a famous Richard Feynman quote. Nature is quantum mechanical. He used a select word after that, and so if you want to simulate nature, you'd better. You better make a computer. That's quantum mechanic. I mean, I haven't quoted it exactly, but something like this. So because the quantum bits in the quantum computer behave by according to the same fundamental principles as

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00:18:03.070 --> 00:18:24.119

Kate Weber: atoms in subatomic particles in the real world, you can simulate those things. And that means you can do things like simulate drug candidates to improve the drug discovery process. You could simulate the materials to make batteries, or we've done work showing that a future quantum computer could very efficiently simulate a fusion energy reactor to improve

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Kate Weber: fusion energy development. So things like that. And then, as you get further along. There are other applications, too. I'll just briefly mention, because I think I would be remiss in this conversation not to. You know. We also know about this application for quantum computers to break encryption right? Because they will be able to factorize large numbers, which is what a lot of today's encryption is built upon, and I'm sure we'll get to

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Kate Weber: later. Get to kind of what that means and how policymakers should be getting ready for that.

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Leonardo Quattrucci: Yeah, again. And I guess that piece is what has really driven the flur of government investment first.st and beyond the science. Frank, coming back to you. You know, the polls show that

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Leonardo Quattrucci: the biggest barrier, both in perception and in reality coming out from the community, seems to be skills or adequate expertise.

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Leonardo Quattrucci: do you see this in your work? And what what kinds of investments should governments make in matching, you know, capabilities to mission when it comes to quantum.

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Freeke Heijman: Yeah, yeah, it's a very familiar problem. Because policymakers, they have expertise in policy making and regulations, but not necessarily in deep, complex scientific domains such as this one is. So I think, for a policy maker. It's extremely important to engage with the ecosystem in your own country.

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Freeke Heijman: So set up Advisory Board or a national council that includes scientists because every country has quantum physicists and also computer scientists who know the state of the art

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Freeke Heijman: and also your industrial ecosystem. So there most likely will be some companies working on this. And then.

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00:20:17.880 --> 00:20:47.269

Freeke Heijman: yeah, you can train yourself and learn also from them what the state of the art is, and then there's 1 warning signal to be made. Be careful, because, of course, they will also lobby for their own funding and for their own company. So you have to make sure. This. This advice you're bringing into the government is a bit neutral and balanced, but I think it's true, it's very important to get yeah, the knowledge into your system

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Freeke Heijman: by our boards or advisors.

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00:20:51.530 --> 00:21:08.160

Leonardo Quattrucci: so, Tom, how are you doing that? I mean Ecosystem as a word and she's suggesting that you need you know to equip top down policymaking with some of this expertise. What's the bottom up vision? And you know more generally the work that you're doing.

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Tom Scott: Yeah. So so we in the UK just concluded the 1st 10 years of our national program. I think we were one of the 1st countries in the world to to announce sort of national quantum

program, and that has yielded a really collaborative, innovative ecosystem in the UK, so that it's really sticky. So there's lots of collaboration between the universities.

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Tom Scott: The spin out some of the larger companies and also with government as well. You know, we invested just over a billion pounds into the ecosystem over 10 years.

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Tom Scott: and I think that's helped to

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Tom Scott: build the relationship between government and the sector. We have a lot of really good relationships with different parts of the system, and we have sort of formal advisory structures as well to feed into some of the policy development. And I think that's really important. I mean, it's really challenging to balance the views of the entire sector. And I think Rick has kind of alluded to that. And taking into account who you're engaging with, and what are the needs of the community writ large is always a challenge.

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Tom Scott: But I think I think you just gotta get out and start engaging with with the community. Because there's some a there's some really interesting things being done. You know, in academia and in industry. But B, there's lots of opportunities for government to support. Given the the state of the technology at the moment.

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Leonardo Quattrucci: well, what are what are examples that have works in terms of these types of collaboration? I mean, frank, I want to come back to you. But after you know, Kate, feel free to jump in based on your experience, too.

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Freeke Heijman: Yeah, what we did in the Netherlands was, write a national strategy for quantum technology. So bring together the hubs that there are so in Netherlands of Amsterdam, Delft, Engel, etc. Bring together the expert and write a vision towards what is realistically achievable for a country like the Netherlands, based on the specific expertise that there are.

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Freeke Heijman: And this national agenda, yeah, raised 600 million from government funding to execute it. Basically. And this execution is really an ecosystem approach going from education. So it really starts with educating. Well, we talked about 10 year olds but 10 year olds, and then all the way up to students, Phds, etc.

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Freeke Heijman: And then it's also about the science and technology and very important. And I think that's the new thing of the last 10 years. Also a lot of emphasis on the industrialization and commercialization. So startups startup support end user engagement public private partnerships.

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Freeke Heijman: Yeah, so these are key ingredients that are needed in such a national strategy.

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Kate Weber: Maybe just to add a couple of things. Leo, I would agree with. You know everything that both Tom and Rica said.

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Kate Weber: along with this sort of evolution of the industry. I think we're seeing some additional policy. Issues come more to the fore. Things like supply chain. How, as the industry goes, how do we think about having a secure international supply chain?

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00:24:34.700 --> 00:24:53.280

Kate Weber: The workforce conversation is changing as well. Right like it used to be that we were very dominated by Phd physicists, and that is starting to change. We have a lot of engineers, and I think, as we get closer to the point where we have fault, tolerant quantum computers, we will also.

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Kate Weber: there will be a much more robust kind of applications, development, portion of the industry, and with, along with that last point I would just note that there's I know we have, like a pretty diverse geographic group on the call here, right? I don't think it's realistic for every country to aim to have like this quantum hardware ecosystem. That's a very expensive

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Kate Weber: prospect. But there are various ways to get involved in this quantum computing ecosystem and this kind of application software development side, you know, that tends to require less investment. And it's different kinds of expertise. So governments could think about that.

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Leonardo Quattrucci: No, it's super interesting. Because I think, you know, when

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Leonardo Quattrucci: when we think about quantum, we always think about building, you know, we see this pictures of chandelier like, you know, fridges with the chip. And then we think about, oh, yeah, we need to build one, too. But that's the emergence as both of you have just mentioned. That's the emergence of a new industry, right? And an industry needs many components to sustain itself. One of those, I guess, is ethics and governance. Right, Tom. And so what are? What are some of the

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Leonardo Quattrucci: questions that you're grappling with in in the space of

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Leonardo Quattrucci: how to govern the evolution of this of this industry.

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Tom Scott: Yeah, it's a really good question. So you know, I think

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Tom Scott: these are potentially very powerful technologies. They are dual use technologies as well. And also, I think, the other thing that I don't think we have a clear answer yet is the environmental impact of of some of these technologies as well. So I think there are definitely things to consider. And you know.

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Tom Scott: we're a real champion for responsible innovation in the Uk. And we set up last year the responsible quantum industry forum with the national quantum computing centre and Uk quantum and tech Uk, which is some of the trades associations in the Uk to start to grapple with some of these questions and so and think about what are the principles of responsible innovation?

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Tom Scott: So around open collaboration and safety and transparency. And and these types of things that the tech developers and end users should be thinking about from the outset. You know, I think I think it's a relatively, you know, quantum computing is relatively early stage in terms of deployment. So I think there's an opportunity to start thinking about these questions now? So that we can have a good answer on some of this stuff when they come to deployment.

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Leonardo Quattrucci: but it seems, it seems like, yeah, cool. You're really you're, really, sort of changing the operating structure of government trying to to build almost like an open source platform, right? Guarding input from

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00:27:42.970 --> 00:27:58.085

Leonardo Quattrucci: as as the inputs emerge and the industry reduces its level of uncertainty. Then you add more variables to what should governance look like? Kate, you must have a lot of these conversations.

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00:27:58.730 --> 00:28:07.499

Leonardo Quattrucci: How do you do that? What's the what's the effective way of communicating such a complex matter to non-technical colleagues?

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00:28:07.740 --> 00:28:11.650

Leonardo Quattrucci: I mean, not just outside in government. But it was at Google, I suppose.

118

00:28:12.970 --> 00:28:20.120

Kate Weber: Yeah, I mean, I think you were. It was a great idea to start the conversation with analogy and analogy.

119

00:28:20.120 --> 00:28:20.440

Leonardo Quattrucci: Perfect.

120

00:28:20.440 --> 00:28:30.220

Kate Weber: That this is one of the best ways to convey sort of the underlying concepts behind quantum computing. And and we've also.

121

00:28:31.030 --> 00:28:38.060

Kate Weber: you know, we're very excited to see the launch of the course and the community. I think just this, I this.

122

00:28:38.720 --> 00:28:40.560

Kate Weber: It is a very

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00:28:41.200 --> 00:28:52.779

Kate Weber: pretty difficult area to understand, and spending a bit of time to, to just at least at a basic level, understand the underlying principles of quantum computing can really help

124

00:28:52.790 --> 00:29:20.950

Kate Weber: to make effective decisions to evaluate. I mean, Freaka kind of get got to this. And of course, I myself have a bias. I'm coming from industry right? But, like there are all of us on the industry side, have, of course, our own interests. And so, having some understanding of the underlying technology, particularly for something so complex is really critical to be able to evaluate those claims. What everybody is saying right?

125

00:29:21.110 --> 00:29:30.189

Kate Weber: Because otherwise you just sort of have to assume that what somebody tells you is correct because you don't understand it, and that that is a big challenge. So I think

126

00:29:30.540 --> 00:29:49.840

Kate Weber: maybe even more than some other technologies which are maybe more straightforward to just sort of like, read up on very quickly and then be able to understand it. It's important to invest a little bit of time and and sort of connect with others who are who have done this before, and maybe who are others who are also just starting on the journey in the policy space.

127

00:29:50.849 --> 00:29:55.199

Leonardo Quattrucci: yeah, you remind me of that quote, I mentioned at the start of

128

00:29:55.730 --> 00:30:10.870

Leonardo Quattrucci: the loud hype and the quite undersold aspects of of this technology that that we should all focus on to build that vocabulary that somebody was talking about in his metaphor or her metaphor.

129

00:30:11.227 --> 00:30:30.509

Leonardo Quattrucci: All right, I want to wrap this up by asking the same question to all of you. You know we have, I mean, without making it abstract. There are some people here in the audience starting their journey onto quantum technologies in general and computing specifically, what's 1 piece of advice to them?

130

00:30:31.920 --> 00:30:38.869

Leonardo Quattrucci: I give you 30 seconds to think about it, and then I'll come to you in reverse order of the question

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00:30:38.990 --> 00:30:40.756

Leonardo Quattrucci: about metaphors.

132

00:30:42.380 --> 00:30:50.459

Leonardo Quattrucci: In the meantime the audience can think about more questions, because we're gonna open Q. And a. After this round of answers.

133

00:30:52.127 --> 00:31:04.950

Leonardo Quattrucci: please. By the way, use the Q&A feature if you can that would be at the bottom of your zoom quadrant. All right, Tom. One piece of advice.

134

00:31:05.550 --> 00:31:26.540

Tom Scott: Yes, I'm gonna cheat, and I have 2. So I think one is. One is don't be put off by the tech like the complex nature of the technology. Like Kate, I agree. Having an understanding of it. Is really important. But I think when we're communicating, communicating across government and with ministers, and so on, like.

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00:31:26.660 --> 00:31:38.404

Tom Scott: it's about what the technology can do to understand what it means for you, and like, particularly how it compares to classical alternatives, and what the quantum advantage in your area might look like.

136

00:31:38.750 --> 00:32:02.449

Tom Scott: And my second piece of advice is to be aware of the hype. And I think that kind of goes back to the point around understanding the technology that Kate made. So there is a lot of

noise in the sector around tech developments and new qubits. And it is really hard, as a non technical person to navigate that and understand what the implications of those developments are

137

00:32:02.450 --> 00:32:18.879

Tom Scott: for policy development in the UK. So just be mindful of that. As you are exploring the quantum ecosystem globally and find a trusted expert who can give you a candid view on the latest breaking news.

138

00:32:19.210 --> 00:32:38.119

Leonardo Quattrucci: Alright, so don't. Don't just learn about the uses, but make it useful to your audience, and beware of the auctioning bias where everybody starts putting out more qubits, but they might not be what you need. Frankie, go, go. You go next.

139

00:32:39.420 --> 00:33:03.480

Freeke Heijman: Yes, I would advise to start engaging in it now. So, although there may be things that application that may take another several years, it is happening now. So also, coming back to what Kate said earlier about quantum computers being able to crack certain cryptography

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00:33:03.800 --> 00:33:19.930

Freeke Heijman: keys, one needs to get ready now, and that is a transition. It takes time. So it's really wise to start getting yourself in the field and getting ready for this quantum revolution that is now underway.

141

00:33:21.250 --> 00:33:29.660

Leonardo Quattrucci: Yeah, so good instinct joining this webinar and better instinct joining the community of practice. Kate.

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00:33:31.400 --> 00:33:32.360

Kate Weber: That's right.

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00:33:34.030 --> 00:33:40.780

Kate Weber: I'm not sure that I have much. I think that these are. These are really good pieces of advice. I mean, I just I think that

144

00:33:41.680 --> 00:33:48.013

Kate Weber: yeah, kind of maybe maybe the last piece, I'll add is, I think it is

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00:33:49.250 --> 00:33:50.490

Kate Weber: You know, there's

146

00:33:51.020 --> 00:33:58.759

Kate Weber: this conversation tends to be hype. And then people sort of responding to like respond to the hype and

147

00:33:58.890 --> 00:34:21.719

Kate Weber: finding some middle ground as a policymaker where you understand the really big implications, and can get people excited about that without overselling things, and is really the challenge. And I think part of that to Frika's point is understanding the timelines for the various pieces of this technology. So I think there are things that are really that you know. The

148

00:34:22.360 --> 00:34:37.370

Kate Weber: implementing post quantum cryptography is probably the most urgent thing to focus on. And that's but there are pieces of this narrative that are both important. There are also pieces that are kind of really exciting to think about now, and and I think

149

00:34:37.850 --> 00:34:41.830

Kate Weber: leveraging without overselling. That's the big

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00:34:41.940 --> 00:35:05.959

Kate Weber: challenge. But it's also what makes it exciting. And it's it's kind of. I find it really exciting to be working on a technology where we have the opportunity to have these conversations at this stage in its development. I think a lot of folks in tech policy are reacting to what's the what's happening in the real world as a result of technologies right now. And I feel fortunate to kind of have the time to have these discussions.

151

00:35:08.190 --> 00:35:20.790

Leonardo Quattrucci: and as you say, okay, it would be learning by doing right. These are things that the hardest things are the ones that no one has done before. So there will be mistakes in fact, error, correction.

152

00:35:20.910 --> 00:35:30.430

Leonardo Quattrucci: learning from quantum, I find it should be a very useful notion to include in government operations any management generally right.

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00:35:30.430 --> 00:35:32.909

Kate Weber: A metaphor in the other direction. Right?

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00:35:32.910 --> 00:35:34.940

Leonardo Quattrucci: Yeah, yeah, exactly. Operating

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00:35:35.850 --> 00:35:50.889

Leonardo Quattrucci: mistakes. I mean, when I was in a big tech company, our CTO used to say, everything fails all the time. That was the operating premise of all the system. So how quickly you correct it is really what makes you win ultimately?

156

00:35:51.483 --> 00:36:12.579

Leonardo Quattrucci: Thanks for this fascinating conversation. I'll open it now to the, to the community that has been populating actually more questions that we'll be able to ask but worry, not because, as part of this community. This is just the beginning of a conversation. I want to go too quickly. Actually, there is one that caught my attention.

157

00:36:12.970 --> 00:36:29.900

Leonardo Quattrucci: Since you know the the Netherlands strategy on quantum was one of the first, st and I like to. I like questions that ask. You know, what would have you done differently what is going well, but also what is not going as well, and should be done better.

158

00:36:31.950 --> 00:36:51.269

Freeke Heijman: Yeah, very good question. Yeah, we had a evaluation, I think, a year ago. So a lot of things are going well, and I think, especially above expectations, is this startup development so that it's growing ecosystem of startups which is really exciting to see.

159

00:36:51.270 --> 00:37:06.630

Freeke Heijman: And also scientifically, it's going really well. And this ecosystem building there's also we have these initiatives, house of Quantum, which is really getting to be a magnet for talent and for companies. So that's good.

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00:37:06.630 --> 00:37:26.100

Freeke Heijman: I think one thing that turned out to be hard, or what is a challenge and a priority also for the next couple of years is the end user engagement. So really getting to concrete use cases and not only thinking of them in an academic setting, but really with

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00:37:26.100 --> 00:37:37.399

Freeke Heijman: companies that will or or public organizations that will implement it. So that work, it's, you know. Yeah. Has taken some time to take up.

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00:37:40.180 --> 00:37:52.489

Leonardo Quattrucci: Yeah, no super. This user engagement is really is really useful, especially as as we were saying before, the industry is a lot more than building hardware

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00:37:52.610 --> 00:37:54.979

Leonardo Quattrucci: right? And use cases.

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00:37:55.495 --> 00:38:08.969

Leonardo Quattrucci: Is part of building an emerging industry. In fact, I mean the another question that goes back to the initial challenge, and here I open it to to the floor, you know. Pick, take your chance. But but what

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00:38:09.150 --> 00:38:20.419

Leonardo Quattrucci: the the question here is about what should you study in order to participate in this debate effectively. But I really think about when you're setting up a team

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00:38:20.750 --> 00:38:36.830

Leonardo Quattrucci: right like Tom's team, like all of your teams. Actually, what types of roles do you need to manage the the emergence of this industry? Right? Because I've lived in myself? It seems there seems to be a polarization between

167

00:38:37.110 --> 00:38:50.550

Leonardo Quattrucci: physicists that have been doing this for ages. And then, on the other hand, integrating this into public sector or businesses, how do we bridge the gap? What kind of roles and literacies should we develop, and how.

168

00:38:53.060 --> 00:38:55.553

Tom Scott: I can come in on that. So

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00:38:56.510 --> 00:39:07.459

Tom Scott: so my team? There are 17 of us, and we are all policy people. But we are looking at the different I guess

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00:39:07.600 --> 00:39:19.780

Tom Scott: areas of policy that relate to quantum. So anything from international to regulation to access to finance and innovation security. You know, all of, you know

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00:39:20.160 --> 00:39:28.877

Tom Scott: through that lens quantum is just another technology that interfaces with all of these different bits of policy and and interacts with the world in that way.

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00:39:29.480 --> 00:39:59.240

Tom Scott: and I think we're starting to work more collaboratively across across government as well like, I think the Uk government is starting to take an increased interest in adoption, and I think those engagements with the likes of the Ministry of Defense, and part of the health and social care and part of energy really mirror the engagement that tech companies have with end users. And so having those people that can communicate across that interface is absolutely critical.

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00:39:59.640 --> 00:40:08.449

Tom Scott: And so we have experts that come in on succumbent who are in the ecosystem, and they really help to translate

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00:40:08.984 --> 00:40:32.650

Tom Scott: the kind of technology lexicon into the end user lexicon. Because that's a real barrier. And so I think, that's probably the most obviously you need technical people, and you need good policy people. But I think having people that can communicate across that barrier, particularly as the technology moves towards sort of availability and adoption is going to be really critical.

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00:40:35.300 --> 00:40:47.230

Leonardo Quattrucci: anybody else wants to come in on that. I mean, is it the same at Google Kate as you set up your team because I mean, I guess this is there's AI, and then quantum. You know, this is complicated operation to set up.

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00:40:49.240 --> 00:40:52.540

Kate Weber: Yeah, I mean, I think it. It is it

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00:40:52.610 --> 00:41:14.090

Kate Weber: as Tom, it looks a little bit different at Google. Our effort is mostly technical. There are a few of us kind of working on this public engagement policy engagement side on quantum specifically. And then there is an element of what Tom said in the sense that Google, of course, has many policy experts

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00:41:14.090 --> 00:41:35.969

Kate Weber: across the areas mentioned that are sort of generalist experts in things like trade policy, economic policy, etc. And our team is working very closely with them on these specific policy issues coming up. We're also working very closely. If you think just beyond the policy space, but the general outreach space with our comms and marketing colleagues.

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00:41:35.970 --> 00:41:58.463

Kate Weber: and that translation between these different world that is sort of where I sit and and where I'm bringing in other members of the team. It's almost like a second right? Like, if we're having a conversation with a customer from another part of Google on how they might use quantum computing in the future, right? Bringing in the right applications, people for those conversations.

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00:41:58.950 --> 00:42:14.639

Kate Weber: so I think there are a lot of parallels. And of course, Google is a very large company. It's going to be quite different at a startup, I assume, but but I assume that everybody is, is dealing with these same issues right? Trying to connect those those dots between the technical and the.

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00:42:14.640 --> 00:42:25.040

Leonardo Quattrucci: Yeah, yeah, I, you know, just a bit of personal experience in in going from a very large company to advising startups. Actually, the.

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00:42:25.170 --> 00:42:28.249

Leonardo Quattrucci: There was a common thread in this, which is

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00:42:28.290 --> 00:42:58.289

Leonardo Quattrucci: when I asked Ceos, or directors of large quantum initiatives, what would you do differently in setting up your team. All of them said I would invest earlier in product managers and program manager roles that operate. As you said, that translation mechanism between technical expertise and business expertise or policy expertise. So this would be seems to be the most common regrets that nobody's correcting for speaking of error correction.

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00:42:59.109 --> 00:43:03.519

Leonardo Quattrucci: Okay, there seems to be a latent doubt around.

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00:43:04.310 --> 00:43:05.230

Leonardo Quattrucci: You know

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00:43:05.680 --> 00:43:30.549

Leonardo Quattrucci: how mature is the policy conversation. Around quantum cause. On the one hand, we're saying the technology is serious but nascent. Lots of governments are investing in it. But how much? Maybe, since you're in in Saudi Arabia, you can provide us a more exotic perspective on this, to begin with, and then have others come in.

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00:43:30.910 --> 00:43:54.059

Freeke Heijman: Yeah, I saw the question in the chat. And I think it's very interesting. I do think also, on the international level, there's a lot of policy making going on so well, I'm here for the World Economic Forum, which is, of course, global. In Europe. You have the EU. So there's a lot of policy making going on there. There's also bilateral partnerships

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00:43:54.060 --> 00:44:10.770

Freeke Heijman: of all kinds. I'm currently with a partner in the Us. Doing a supply chain mapping for NATO, which is also and it's, of course, international year of quantum declared by the United Nations. So there is

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00:44:10.850 --> 00:44:37.739

Freeke Heijman: activities on the global level. I do think it's something we need to pay attention to, because the risk is fragmentation. If every national government has its own policy, then we will have fragmented ecosystem, and in the end it's also about interoperability and and trade, and, for instance, the supply chain. It has certain vulnerabilities that we all share.

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00:44:38.171 --> 00:45:04.938

Freeke Heijman: But I have to say I'm here in Saudi Arabia. I'm really impressed how seriously they're taking it up, because you know, also for them they? They are maybe a bit later than than the UK or the Netherlands or the Us. But now they within their vision, 2030 to diversify their economy. They're really serious about yeah, placing bets in quantum. So yeah, I think, it's maturing

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00:45:05.480 --> 00:45:07.059

Freeke Heijman: on in a good pace.

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00:45:09.810 --> 00:45:14.769

Leonardo Quattrucci: anybody else has. You know, other relevant experiences. You guys want to share or.

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00:45:16.520 --> 00:45:26.329

Leonardo Quattrucci: I mean, how, how much do you work with other governments. Tom, for instance, on this I mean on your you know week, how much, how many calls do you have with your counterparts?

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00:45:26.670 --> 00:45:40.240

Tom Scott: Yeah, so it's a great question. So so I work more on the domestic sides of the house. But we have an international team. Frika mentioned like mous. So we've signed 5 and round of understanding with the Us.

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00:45:40.240 --> 00:45:57.350

Tom Scott: Canada, Denmark, Netherlands, and Australia. And you know those are mechanisms through which we can collaborate with those countries. And there's also the sort of multilateral picture. So there's the quantum development group of 13

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00:45:57.824 --> 00:46:08.579

Tom Scott: nations which gets together on a regular basis to talk about quantum and sort of alignment across the globe on on policy development and ecosystem development. So

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00:46:08.730 --> 00:46:10.290

Tom Scott: it's it's, you know. I think

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00:46:10.800 --> 00:46:34.389

Tom Scott: that's a relatively mature discussion like. But there are. Only, you know, there aren't many countries that have a really substantial content program because the technology is so new and the barriers to entry are relatively high. But you know, I think, what Freak is saying about where where she is at the moment sounds. Yeah, there is definitely an increasing recognition that this is going to be important. Across the globe, irrespective of whether you have a program now or not. And I think

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00:46:34.390 --> 00:46:43.630

Tom Scott: that point around engaging now with the technology to help co-develop use cases and drive. The technology is is super important.

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00:46:47.270 --> 00:46:52.669

Leonardo Quattrucci: alright, just going through the list. Does anyone have

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00:46:53.200 --> 00:47:01.510

Leonardo Quattrucci: is anybody doing experiments, or has seen initiatives in healthcare, there, seems to be a specific interest in healthcare.

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00:47:02.450 --> 00:47:04.879

Tom Scott: From your portfolio of observations.

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00:47:05.700 --> 00:47:23.449

Tom Scott: I'm going to point to the new report that the National Quantum Computing center in the UK. Has just published, looking specifically at quantum computing in healthcare and life sciences. So there's lots of really interesting stuff in there. And it's not too technical. So it's quite easily accessible.

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00:47:24.080 --> 00:47:26.590

Leonardo Quattrucci: Fantastic. Will you share it in the community, Tom?

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00:47:26.910 --> 00:47:28.270

Leonardo Quattrucci: Sorry to ask you.

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00:47:28.270 --> 00:47:35.277

Tom Scott: Yes, yeah, yeah, it's it's online, but I can. I can share the link after the call. I'm happy to do that.

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00:47:35.570 --> 00:47:41.217

Leonardo Quattrucci: Fantastic. Yeah. See? By the way, this question was not prepared. It was just

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00:47:41.823 --> 00:47:48.542

Leonardo Quattrucci: It's better to believe in coincidences, I guess. Okay,

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00:47:49.700 --> 00:48:09.800

Leonardo Quattrucci: actually, is there? Is there another question there is there, and I will ask you to also post it. But but thinking about your journey into quantum is what is the best resource you found in getting up to speed and then helping others become quantum literate.

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00:48:10.180 --> 00:48:20.409

Leonardo Quattrucci: and it can be a piece of reading. It can be a course, but it can also be, you know, finding experts share, share a little bit your methodologies for becoming quantum literate

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00:48:20.570 --> 00:48:21.760

Leonardo Quattrucci: personally.

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00:48:27.525 --> 00:48:30.270

Kate Weber: Oh, go ahead!

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00:48:30.470 --> 00:48:53.589

Freeke Heijman: Well, yeah, the way my journey I think I learned best from teachers. So I think I engaged with many professors, but also Phd. Students. And I asked questions and and yeah followed some lectures. So to get some sort of the the baseline of knowledge that I think a policymaker needs to know.

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00:48:53.590 --> 00:49:09.879

Freeke Heijman: And then for me, as a very person who's very interested in these kinds of technical fields, it's it's more the challenge not to dive too deep like doing the math, etc. Well, maybe it's not needed for you to do that, because, yeah, you don't need it in your job as a policymaker.

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00:49:09.920 --> 00:49:18.909

Freeke Heijman: But for me it was learning from experts, and I have to say nowadays, I think you can also ask a lot of questions to to some

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00:49:19.060 --> 00:49:22.299

Freeke Heijman: AI tools I won't name further.

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00:49:25.540 --> 00:49:39.740

Kate Weber: Yeah, I mean, this is the way I learned best as well and have learned a lot, you know, just organically from being at Google and working with experts over the years. But I think there is. I mean.

218

00:49:39.950 --> 00:50:04.039

Kate Weber: this is part of the reason, I think, that we were interested in supporting this apolitical effort is, we did see a bit of a gap here in this kind of content that was very widely available for a non-technical audience. I think there are some great courses offered by various universities targeting non-technical people. Mit has one. They're out there, but

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00:50:04.580 --> 00:50:12.289

Kate Weber: but at a sort of large scale. It can be hard to find resources that are sort of

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00:50:12.420 --> 00:50:27.799

Kate Weber: at that right level that don't take too much time to get through. But still you're getting this grounding. And and they include input from the experts. So you know, of course, this is part of the reason we're all here, but definitely check out the course in the community of practice.

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00:50:29.960 --> 00:50:31.269

Freeke Heijman: And tell him anything you'd like

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00:50:31.270 --> 00:50:50.169

Freeke Heijman: turning. Yeah, I see Louise Turner in the chat mentioning this state of quantum computing report. That's indeed such reports are very digestible for non-technical people. But yeah, give give the ground basics of it.

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00:50:51.380 --> 00:51:01.290

Leonardo Quattrucci: Yeah, one of the one of the stats that is always fascinating. So before before joining aws, at the time I was a civil, I started my career as a civil servant

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00:51:01.330 --> 00:51:23.110

Leonardo Quattrucci: and and I found that the methodologies of learning changed a lot. And then, when I started doing this work with a political. The thing that is has always stuck with me is that when you asked people to choose in government, so people like you who are joining us today here. Now, when you asked, What's the

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00:51:23.380 --> 00:51:31.529

Leonardo Quattrucci: type of learning that you give you the most confidence to then have a policy conversation.

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00:51:31.890 --> 00:51:39.540

Leonardo Quattrucci: It was never one, but it was always a combination of a course plus a community. So the ability to

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00:51:39.560 --> 00:52:04.159

Leonardo Quattrucci: what you're saying here to ask questions to even peers. They don't need to be experts, but to validate assumptions, to navigate the uncertainties. Because I guess here there are 2 elements. One is how uncertain or certain is the technology or the facts that we're talking about. And B is how contested is the policy issue. We're trying to tackle.

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00:52:04.160 --> 00:52:13.160

Leonardo Quattrucci: And so having a community of reference has always been the top answer from apolitical from the Apoliticals.

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00:52:13.527 --> 00:52:34.870

Leonardo Quattrucci: If I may call it like that and which confirms what you're saying right, in a sense, to to use your term from earlier. Craig is, build your own advisory board when it comes to this, and it can be composed of humans machines experts in different fields knowledge. But but there is.

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00:52:35.070 --> 00:52:56.606

Leonardo Quattrucci: There's a group that sort of validates, because even in quantum. I think one thing to be precise about is there are different types of expertise and different ways of building a quantum computer. And experts about one are not necessarily experts about the

others, so that increases the complexity. So it means your your advisory board needs to be larger.

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00:52:57.360 --> 00:53:01.063

Leonardo Quattrucci: but okay? So

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00:53:02.490 --> 00:53:13.269

Leonardo Quattrucci: I think the I will close with this question, that is, if you were to name one challenge that governments should start solving today in the quantum world. What would it be?

233

00:53:15.280 --> 00:53:18.940

Leonardo Quattrucci: In 30 seconds or less?

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00:53:23.670 --> 00:53:27.640

Leonardo Quattrucci: I'll give you a moment as people

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00:53:29.480 --> 00:53:32.310

Leonardo Quattrucci: the resources to the community of practice.

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00:53:34.050 --> 00:53:35.760

Leonardo Quattrucci: Who who wants to start.

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00:53:40.180 --> 00:53:40.900

Leonardo Quattrucci: Tom.

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00:53:41.110 --> 00:53:48.660

Tom Scott: I can have a go. Yes, so there are loads of challenges. Is what I will say like this is a really hard sector to work.

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00:53:48.660 --> 00:53:50.100

Leonardo Quattrucci: Cheating this time. Huh?

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00:53:50.500 --> 00:53:56.120

Tom Scott: Yeah, I'll stick to that. I promise. I think governments

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00:53:58.260 --> 00:54:26.800

Tom Scott: Government acting as an early customer is really important. To signal to the wider end, user community like, confidence in the technology. And this really helps to helps companies and and companies developing quantum computers to develop their sort of commercial pipeline and attract more investment. Because I think the viability of quantum computing companies is tricky, because, you know, there's not the revenue streams are

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00:54:27.285 --> 00:54:33.594

Tom Scott: hard to come by. Given the stages of the technology. So I think from a government perspective like government procurement,

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00:54:34.350 --> 00:54:41.249

Tom Scott: risk, technology is a really, it's a really powerful lever, and that's something that.

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00:54:41.250 --> 00:54:41.980

Leonardo Quattrucci: Beautiful.

245

00:54:41.980 --> 00:54:42.510

Tom Scott: I think.

246

00:54:42.510 --> 00:54:49.869

Leonardo Quattrucci: Procurement is an obsession of mine. So I'm I vote for this answer. Frankie Kate, who wants to go next.

247

00:54:54.130 --> 00:55:01.470

Kate Weber: I can go next. I would maybe.

248

00:55:02.530 --> 00:55:25.809

Kate Weber: Well, maybe this is cheating. To say that I mean the most immediate thing, as we've noted is to understand what post quantum cryptography is, and how to implement that right. That is the thing that governments should really, that really is very urgent and needs to be done. Now, of course, that is not a quantum computing technology, right? So that's that's preparing for the quantum computers in terms of the

249

00:55:26.260 --> 00:55:28.300

Kate Weber: technology itself.

250

00:55:28.790 --> 00:55:45.380

Kate Weber: This maybe goes along with what Tom was saying. But I really think, really understanding this application space and working with experts and understanding. You know what is realistic on what timelines in terms of applications for quantum computing is probably what I would note.

251

00:55:46.530 --> 00:55:54.400

Leonardo Quattrucci: Yeah, time is security when it comes to quantum. So pick your C's 1st strategy to respond, yeah, Frankie.

252

00:55:55.420 --> 00:56:14.840

Freeke Heijman: Yeah, I agree. What has been said. So if I would name another one, I would say my concern. And it's more long term concern is that quantum computing, if it's concentrated only into some companies or some countries space, it will

253

00:56:14.840 --> 00:56:34.340

Freeke Heijman: enlarge the defied, so to say. So I'm I'm really in favor of a balanced and an equitable development of this technology. And that's why I think it's so important that all of you engaged in this and that we all together make sure that this technology yeah, develops itself in an equitable way.

254

00:56:35.000 --> 00:56:41.219

Leonardo Quattrucci: So procure, secure, engage. These are the 3 things that. I hope

255

00:56:41.290 --> 00:57:08.393

Leonardo Quattrucci: you will start or continue doing after today. With that I want to thank our speakers very much for this conversation on World quantum day, and I want to invite you to submit. Yes, emojis of applauses popping. I wanna. I want you to turn, please, that appreciation into a score from one to 10 in terms of how much you found this event valuable.

256

00:57:08.960 --> 00:57:29.220

Leonardo Quattrucci: And lots of hearts, too. Beautiful. So please, as you fill in the survey and you turn hearts into numbers. Bookmark this link that is gonna be shared in the chat, which is what Kate was mentioning, which is

257

00:57:29.430 --> 00:57:54.890

Leonardo Quattrucci: the the launch of a new apolitical course, with the collaboration and support of Google Quantum AI, and that is really to respond to many of the questions that you raised, but also the challenges that the the panel raised around preparedness as the best insurance for a future that is desirable, right? This. These are exponential technologies.

258

00:57:55.020 --> 00:58:17.820

Leonardo Quattrucci: We've seen it with others. So what's happening today is not an indication of what can happen tomorrow, and the only way to manage is to prepare. So please do all of us a favor engage by informing and equipping not only yourself, but colleagues, to then procure and secure better.

259

00:58:18.423 --> 00:58:28.259

Leonardo Quattrucci: And with that I wanna thank you again. For joining us today. See you in the community and happy world. Quantum day.