POD OF JAKE
#64 - VIJAY PANDE
AI-GENERATED TRANSCRIPT

Jake 00:59
Thank you so much Vijay for joining me on the show today, I really appreciate you taking the time. You are a general partner at Andreessen Horowitz, and previously spent a lot of time in academia specifically at Stanford. And you've got a very science heavy background, which I can I can try to understand. But some of it's a little more difficult. And so I'm looking forward to speaking on some of these terms in plain English today. But it's a pleasure to have you on I think the best place to get started would be for those who don't know you if we could just start with your story from basically as early as you're willing to start to where you are today.

Vijay Pande 01:34
Yeah, sure thing, and thanks for having me here. Yeah, so if we go way back, I mean, maybe an interesting place to start, is in high school. So in high school, I joined Naughty Dog software at that time was really just the founders, Andy and Jason and me. And it was an indie as a high school friend of mine, and and Jason, a friend of his. And it's actually, I think, a remarkably powerful experience to be in a startup in high school. The three of us were, you know, developing the games, writing the software, working with electronic cards, our studio, and to sort of learn all these mistakes early, was a great educational experience. But then also, you know, I think it really got me sort of hooked on that startup bug and wanting to get back to that as soon as I could. But in parallel, the other love of my life intellectually, has been science very broadly. And so I did a lot of science stuff in high school, and then went to college at Princeton, and got a PhD at MIT, both in physics. And you know, when I was at MIT, I did see something really remarkable. So I got there in 92. And I graduated in 95. And over that three year period, there was a dramatic shift, in that there was like, a ton of physics majors and 92 is like 100. And then 100, went to like 10, in 95. And then biology flipped. Biology went from something like 10, to 100. And I think there was something in the air at that time, the sense that, as exciting as physics is, biology really is the future of what we'll be able to do. And especially, I think the tools for making biology, quantitative, predictive, powerful, all the things that we like about physics was was was emergent. So we fast forward a bit, I get to get to wanting to become a professor and also want to reconnect with the

startup world. So I ended up taking a faculty position at Stanford. And at Stanford, I was in several different departments primarily in chemistry, but also in structural biology, computer science, and also Chair of biophysics. And the work that my lab there was very much on that intersection. One of the key things that people may know about is that the folding and home distributed computing project was something that I developed and came out of my lab. And really, I think that was the came from the realization that we could do many exciting things at the intersection between computation and biology and physics and computer science, if we had enough computer power. And so at that point in 2000, you know, there wasn't a lot of computer power compared to compared to what we have today. And, you know, just to even set the stage like in 2007, we get a Guinness World Record for folding home being the most powerful computer in the world. And now that's like, I don't know, like 50 bucks 25 bucks a day on Amazon. Just the power of Moore's Law, really, I think was an exciting combination of sort of driving these forces together. At the same time, when you're at Stanford, it doesn't take much to to be connected to sand hill, you know, we're venture capital is just literally up the road. And so, while developing folding home and pushing the science side, I was also involved with many startups. And in those two worlds really connected in 2015 when I really had had the sense that it was time to take these ideas out of academia, and that we're starting to see companies and the potential for great tech like companies using the power of Moore's law and engineering and other great things rather than technology applied to biology and healthcare. And so I left Stanford to found the bio funds at Andreessen Horowitz, a venture capital firm. And in that period, I think, you know, at that time, our thesis was that machine learning, engineering biology, these areas would really transform many different industries in designing drugs, diagnostics, and in how healthcare is done. And five years later, I think we have this portfolio of companies that really reflect that. And it's exciting to see that idea, which maybe seemed heretical, just five years ago, now become really quite entrenched. And that AI and drug design and healthcare, something that you see much more commonly now. So I am like a kid in a candy store these days, I think with all these trends coming together, it's an exciting time to be in this space, and working with intelligent people, and looking forward to trying to

build that future where technology really fundamentally changes the nature of human healthcare.

Jake 06:15
Yeah, it's awesome, I look forward to digging into a number of these different, different, you know, subjects. But I think that it's great the way that you told your story, you know, touching on a few different trends, going back to even when you were at school, seeing that a lot of you know, the popular physics major was was becoming the popular biology major Can you speak to at the time, or maybe in reflection Now, why you think that was going on why people were viewing biology as the next big thing.

Vijay Pande 06:43
I think it's a couple different things. And I think part of it was that you could actually really measure interesting things in biology. And Human Genome Project was a key part of that, I think, just even measuring and reading our own DNA was a key part of it. And then once you can measure things quantitatively, you can make quantitative predictions. And ironically, it was a time where many areas in physics measuring became very difficult. And so many years of physics, like string theory, if you don't have anything to measure, and so people who loved sort of math and sort of computers and the quantitative side of things, it used to be that physics was the place to be. And I think we were sort of seeing that actually, now this could be applied to biology. And in for me, like, in as much as I still love physics, and still think about it. biology is all around us. It's human health. It's you know, we all have family members or loved ones that have health issues. So it's all of that. But it's all these other things, too. It's like, I think it will impact food, it I think will be one of the key solutions, or even addressing things like global warming, I think you've put all these pieces together, physics almost was like the science of the Cold War, nuclear war, nuclear bombs, rockets. And biology feels like the science that we need for today.

Jake 08:06
Right? Yeah, that makes sense. So I mean, someone listening to your answer might presume that you studied biology, but you actually went you got your degree, as you mentioned, from Princeton, in physics, and

then later your PhD from MIT, also in physics, what drove your decision at the time, despite maybe, I don't know whether or not you were sort of aware of this trend towards biology at the time, or the sensibility of pursuing biology as opposed to physics in those years? But I'm curious what led to your decision to go down the physics route? And then separately, a little bit of a different question. But if you were, you know, going into college now, assuming that you did want to go to college now. What would you What? What do you think you would be studying today?

Vijay Pande 08:48
Yeah, so that's a great question. And it's literally a topic, common dinner table topic, because I have a 17 year old daughter who's thinking about these things, and asking a lot of my friends who are in academia, these sorts of questions. Yeah, I think at the time, the beauty of physics is the sort of rigorous quantitative training. And it's pretty common that you don't use the actual training that you did in school, like the literal project you worked on, but that a lot of going to school is learning how to learn. And so the the the sort of going through a physics PhD, I think, allowed me to get into Bayesian statistics very quickly allowed me to get into machine learning very quickly, allowed all of that to come very naturally. And and I think that was my hope. And today, it's unclear where that may be. It may be computer sciences, I think to do that, because as computer science becomes sort of a key part of everything. If you have that fundamental computer science background, you can move into a lot of different areas. I think for a while physics was that central discipline that allowed you to leap and I think that was my hope that no matter what it would be a useful sort of training. Today I better probably is computer science kind of a boring answer. I think in the future it will be bioengineering. But I think, right now at this moment, computer sciences, I think on stage.

Jake 10:12
Yeah, I think there's, there's certainly cases, especially like yourself as an investor, where it's valuable to sort of take the contrarian view and go against the grain. But in this case, you know, computer science as a degree seems like a pretty good solid bet, even though it may be somewhat consensus.

Vijay Pande 10:28
It's a boring answer, like, especially since like 70% of like Stanford undergrads take some computer science course or something like that. I think though this may change in 10 years, it could be that new programming paradigms mean that actually people do very little programming. and machine learning as it is, is kind of a different way of thinking about computers, and very little programming more about data engineering, and more like statistics. So I think it's very much to the degree of the moment, it will be fun to see how that changes. And that's always the fun thing about life, I guess.

Jake 10:59
Yeah, no, definitely. So you wrap up your education, and then you go straight into academia from there. And that's when you spend like 1015 years at Stanford.

Vijay Pande 11:07
Yeah. So I got to Stanford in 99. And left in 2015. And, you know, it's actually a really interesting time also from, sort of, for being at Stanford, because I think Stanford now is extremely highly regarded. It was very much on the rise during those years into that. And I think there's a lot of interplay between venture capital and Stanford. And that was very intriguing to me. And I think it's still, I think, a real strength University. It's and, you know, for undergrads, they're there, you walk around, and you just see the names on the buildings. And these are the icons of tech. It really is very inspirational. I think people get to Stanford, with many of them having the the sort of dreams to do something really grand. And that's maybe the most powerful thing, because if you don't set your sights high, you will do something good, but not great. And it's those students that come in and maybe don't even know enough to know what they're saying, is believed by common wisdom to be impossible. And then as they learn more, with a little more open mind, they actually can disrupt the previous generation and realize like, Well, yeah, I there's a reason why they say it's impossible. But I have a new way a new idea. That spirit is very, very exciting and common to both aspects of academia, and venture capital, and just, you know, this ecosystem that we're living in here.

Jake 12:32
Right, yeah, no, that makes good sense. I think, you know, I definitely want to talk about like folding at home awesome project, you might, as you mentioned, the Guinness World Record. But before we get into some of the science, I want to talk about, you know, you mentioned Stanford, obviously, and, you know, spending a lot of time in the Bay Area in general. So I'm curious to sort of hear your perspective on, I guess, San Francisco and the Bay Area at large, and where it stands today, and its evolution of sorts, and then separately, education, you know, given that you taught this, this huge MOOC with Balaji, back in, I think, 2013. You know, an interesting thing that was probably ahead of his time, in terms of like, MOOCs, I think it was like one of the largest ones ever at the time. And so I'm curious to hear like, both on education, and the bay area, where do you think we are? And where you think we're going? I know, this isn't like where you invest, necessarily, but I'm sure you have some sort of perspective.

Vijay Pande 13:28
Yeah, no. So the the central question for everything I think, in life is scaling. And so as great as the experiences I've had at Princeton, and MIT, and I was actually at Berkeley in between that to Stanford, these are all great universities, if you actually count the number of people per year that they educated, you know, shockingly small, compared to, let's say, the population of the world. And so the question is, how can you scale and you made an interesting allusion to, you know, whether one would even go to college at all, I think what is really different today than when I was growing up, is just access to information, just broadly, just you could really have access to anything like even just Wikipedia, you could, in principle, go through Wikipedia and teach yourself anything. And so I am intrigued by what we can do to help the world scale in his education, I think that would be the greatest impact that we can have on advancing humanity. Because as people get smarter, they can make greater contributions, those contributions multiply with each other, and there's this, we all raise each other up. Now, the question is how to do that. And I think the reality is that while in principle, you can hand someone a book or a MOOC, and and some people can teach

themselves for a lot of people, it's hard, much like you can like put someone in a gym and that doesn't mean they're going to work out and become an MMA fighter or something like that. Often they do need help or encouragement or even just structure. And so those are, I think, the open questions for how can we take sort of what we love about What the academic setting does, which is that structure, some sense education, actually, in many senses, the network and the social aspects and the people that you meet, and how can we sort of scale that? I know, my colleagues at Stanford and other universities are asking themselves this question all the time. And that, given the resources that they have, I think they do feel a duty to educate more people. And the question is how to take the experiences of these places and scale it I don't think anyone has a really good answer yet. MOOCs, you know, are an intriguing first step. And like, you know, I know my older daughter mentioned before, she does a lot on Coursera. And, and, and has really valued that. And there's many platforms like that which you can learn even Khan Academy and so on. But I think, frankly, it's really still an unsolved problem, and how can you sort of create the network part and the motivation part? It's ironic that it's not the education part. That's the hard part. It's not like the book or the knowledge, it's the structure and getting people to find a way to absorb it. And I think until we resolve that, I think we wouldn't have addressed the report real problems.

Jake 16:07
Yeah, I think, in large part, I agree with that perspective. And people I think, as a result of COVID, realize that there's like a lot more to college than education or even regular school, like they started to realize that like, kids and middle school, or whatever, it's as much daycare as it is, middle school education and things like that. And just having kids home with parents trying to work posed a whole new set of problems that may not have come to light without COVID. And sort of interesting, now that we have them, you know, overnight to, you know, new problems to solve. But I want to go back on another part of the original question. And if you don't have a strong perspective, we can skip it. But San Francisco a lot of people Wailea, similar to how you don't have to go to maybe Stanford or Harvard anymore to Yeah, barnatan, you don't have to be in San Francisco anymore to start a tech company. What do you think of this

trend of, you know, people being able to start companies from anywhere? And what does it mean for the future of the Bay Area?

Vijay Pande 17:02
Yeah, I noticed two theses here that could play out. So one thesis is that, you know, great companies are built everywhere. But that to really have them to scale. Still, the that network that is the Bay Area is going to be really critical. And I think this thesis is most relevant if after COVID, we go to mostly, mostly in person, so let's say two or three days a week. And what that could mean by being sort of mostly in person is that that alone would greatly increase actually increased the power of the Bay Area, that traffic will go way down, people's commuting time would go way down, people may live farther, but it's not a big deal. And that what people really don't realize is just how big the Bay Area is, if you put London or New York and that footprint into the bay area, it's like a little thing inside the bay, that scale of the Bay Area is really unique. And I think one thing is this is actually this will just scale the Bay Area and that network effect, as powerful network effects can be will be dominant. Second thesis is that, okay? People really won't go back in person that much. And that people will be mostly remote first. And that for remote person, obviously, it doesn't matter where you are, and that people will go to places to minimize cost of living, and then these companies will be built just completely distributed fashion. And that's appealing in many ways. And you can imagine that you could be much more efficient. And, and so I think that thesis also is really relevant to poke at in that world, what I think you would want to have is not San Francisco, but that San Francisco spirit. And that's aspect of culture is not a small thing. I have founders who, you know, they aspire to build $10 billion companies, 100 billion dollar companies. And in some places, you say that you want to do that. And people like laugh at you. They think that either you're being naive or stupid or grandiose. And in the Bay Area, you know, it's it's not unreasonable for that to be an aspiration, and very few people can do it. But it's something that we all know people who have done it so that it's it's, it's a culturally more acceptable aspiration. And there's a lot of aspects of the bay or culture which are really powerful for doing these grand things. And to the extent that that culture can be spread and distributed, and maybe by people who have been here that day, take

it with them. And now there's a Barrett display for that, that could be the way to basically scale to here even further. Where now it's not just scaling because the left traffic and being further out, but that that culture now is pervading the country, maybe the world, I suspect, certain type of companies will still kind of need to be in person Some may be very well distributed. And so I laid out those theses, because I think we'll probably see both. But if I had to make a bet for where we're going to be in 100 years, I bet it would be the second.

Jake 20:11
Yeah, that's really interesting. Because in a way, I think the two theses you laid out like the first one almost depends on slowing acceleration to the future, if you buy the premise that the future is more remote and more online. But if we go back in the near term, and, you know, right now, we're like, a lot of people are fully remote. But if post vaccine, we go back, and most people are on a hybrid schedule, or even five days a week, like old times, then, you know, times, like a year ago or whatever, then then maybe that that bodes well for San Francisco in the near term. But whether it's the near term or the long term, it seems that there's this shift out of the Bay Area. And one of the interesting points I think you made is like, it's imperative that the culture, not necessarily like one, you know, monoculture spreading around the world, but very least, this idea that, you know, someone can say that they're going to go build a billion or $10 billion company, and not get funny looks, but actually get like encouragement. And, you know, people, like actually considering their ideas and maybe giving feedback or whatever, but like this, the sort of response that you would expect of like an ambitious group of people in San Francisco in the 2000s, or something like this, that that could spread around the world and now seemingly have like, really good impact, I hope for for entrepreneurship on like a global scale.

Vijay Pande 21:26
Yeah. And I think it's this transition is I sort of when not if, and that's why I think, but if the wind could literally be 100 years, we'll see, I think the challenge will be that, in the end, certain things you will still want to do in person. So I think if you have a spouse, you don't want to have a virtual spouse, where you see them only on zoom, and maybe hang out and do do offsites once a quarter

with them or something like that, that would be I think, not what I bet a lot of people wouldn't want to go for that. And similarly with your friends, you probably want to sort of see them semi regularly. And I think it's these social networks, that will, people will want to be have them physically. And to the extent that social networks overlap with work networks, now the work networks are going to be in person. And that shifts us to that first one. So kind of like how education isn't really about education, like solving education is about solving the human part. I think there's a very much a human part here, because I think we have all the tools to work remotely. The question is, are we going to want to do that? Or is that going to be kind of a dreary life where we're efficient, but like, but just everyone hates it? And I actually don't really answer that I think I think post COVID Well, I have a gut feeling as post COVID, there'll be a bunch of people will be very excited to go back to sort of seeing people in the office, and maybe a group of people that are just preferring the efficiency. And so maybe we'll start to see these experiments, both experiments go forward.

Jake 22:57
Yeah. And one more point on this, because I think it's interesting, I actually heard your partner's Ben and Mark, they do this show on on clubhouse, I'm sure you're aware. But maybe listeners aren't one on one with ANZ highly recommend. I've listened to like, five, I don't know how many there are maybe seven or eight now. And I just listened to him on on podcast form after the fact. But one of the subjects they covered was basically how surprised they were by how efficient basically, and effective companies have been a lot, you know, most of maybe not most, but I, the way I understood it was like most, if not all of their investments had basically benefited in productivity from this shift to remote. And they were very surprised to see that. Do you have sort of a perspective there? Especially on like, when I'm listening to that? I'm like, okay, that's interesting. I think for me, just looking at myself, I think it's sort of overestimated how productive we were in offices and like underestimated how much time is wasted, like in between or distracted or just like on the internet, on your computer or whatever. And then, so I thought like, well, maybe it's not, maybe it's not that we're surprised by how productive we are remote, but actually, we didn't realize how unproductive we were in

person. And then secondarily to that I'm curious if there's going to be any, like they're sort of making that it seemed that they were making that assessment now like a year into COVID. But I wonder if there's any long term effects of being remote to your point, like realizing that there's sort of human interactions that we miss, and we might be super efficient, but three years into it or something like that these these things start to pop up that we realized like, Oh, this isn't actually a viable solution moving forward.

Vijay Pande 24:31
Yeah, I think this efficiency is kind of a remarkable silver lining of of the disaster. That is the pandemic then I think, obviously, nobody really no one wanted this. But I strongly feel that there's more to life than being efficient. And that I could imagine, and we already see this, like depression, suicide, all that stuff, it's up to so the two could be good. It's hard to know what the causes are, but it the two could go hand in hand and it's just stressful to be working from home sounds good. But I think too often you start to realize you're really living at work. And that doesn't sound nearly as good. And that work has I think seeped into people's lives at every hour. And so we are way more efficient. But I think having the boundaries can could be more healthy. But there are solutions, right. So perhaps I have friends that have like just dedicated certain rooms, or even like, you know, you can get these little ad use these little sheds, where you get a shed in your backyard, and that shed is your office and you physically go there, often you physically leave the office, but still, like, you know, interest in your backyard. It could be that people just need to refine sort of how they work from home such that they can sort of get everything done. And so they're, you know, their kids aren't in the zoom, like when it's a critical meeting, and so on. I catch when my youngest one is watching TV or outside, I don't know if you can hear it. Hopefully you can't. But you know, these things. The houses weren't designed for it, but maybe they could be. And maybe that would address this. I love the idea of starting from a clean sheet of paper and asking, given that we know we can do remote? What is the best way to do this? How can we sort of if we sort of didn't have an office before? Would we actually want an office would be what if we start from clean sheet paper? What would we do? It's a fantastic time to be asking that question. And I bet we'll see lots of

experiments. And but the predicting human psychology is a tricky, tricky thing.

Jake 26:31
No doubt, definitely. I'm likewise excited about the blank slate with all of it, all of it. I think that there were some sort of arbitrary lines that might have been legacy from from old, you know, things that had Yeah, exactly things that just had to be done a certain way that we can now realize that's actually not a constraint, I'm just take a whole new view. And I'm bullish on the idea that people may in the future be working like remotely, but not necessarily from home alone, which seems to be just generally a bad solution or home with your kids. You know, in the room next door, I cannot hear the TV. But I know a lot of people are dealing with similar issues. So anyway, I want to go now like more into your your sweet spot. And let's let's start with folding at home. The project that you started while at Stanford, you mentioned the Guinness World Record for the computing power. Can you explain what that is? And sort of layman's terms are what that was when you started and what it's grown to today? And why it's important?

Vijay Pande 27:30
Yeah. So you know, one thing about a lot of areas in biology is that actually, it just is very complex. And the complexity really dwarfs anything that you see in in areas of physics, because of just there's physics is typically very simple things. And that what we're talking about here is an emergent degree of complexity that is present in some physical problems, which but then they share the same computational needs. Just even simple things like so the original goal of following a homeless just to understand how proteins, this key molecule in biology in our bodies, assemble themselves. And this assembly processes is critical for function critical for many areas of disease. In fact, many diseases like Alzheimer's disease are believed to be diseases a protein misfolding, that when that process goes wrong, it can be very toxic and dangerous. And so in 2007, we actually were running on ps3. And so folding home was, I think, one of the pioneers, in many things, not just sort of a distributed cloud like infrastructure, but also GPU infrastructure, running on actually GPUs before it should CUDA existed. And so ps3 is kind of like GPUs there.

And that having all of that computer power with a whole bunch of ps3 is, is what basically got us to that petaflop scale. So petaflop is 10, to the 15. So 10, with 15 zeros behind it. And that was an immense scale. At the time, it was something where, you know, the fastest supercomputers granted, they have a different architecture, optimizing for different things, we're nowhere close. And it allowed us to simulate for the first time how proteins assembled how they fold it, which was a huge thing. And so the petaflop was sufficient for that. And that was, for me exciting, because that was very much the work that I started even my PhD so it was sort of a lifetime achievement and also important scientific milestone. Since then, since 2015, when I left Stanford, the project's been in the hands of Gregory Bowman, when actually my former students who's a professor of Washington University in St. Louis, and Greg has done a team has done a fantastic job of pushing folding home during COVID. So COVID, during COVID folding home got an exaflop. So that's 10 with 18 zeros after it's floating point operations per second. So it's a you know dickless amount of computing power, especially compared to what we even had before. And so, Greg and team have been using folding homes power to understand aspects of key proteins and COVID. And so actually try to look for COVID therapeutics. It's something which is still very much at the bleeding edge of computation, as we always hoped to be with folding at home. But it's been very rewarding to see the early days advancing some very fundamental understanding about physics. And now really moving into the things that we've dreamed about, or where these resources can be used for critical error in human health.

Jake 30:35
So can you elaborate a little bit more on like the the impact or like the outcome that's expected there? Like I understand the immense amount of computing power, but how do you expect the sort of innovations that you've got with fold at home to sort of translate into practical uses and people? Or is that not sort of the, you know, is it more just at the idea stage that you're trying to understand these proteins first?

Vijay Pande 31:00
Yeah, I think there's a little bit of still the fundamental science, but I think in terms of the parts that are practical, in the end,

proteins are still very, very small. So they're difficult to you can't see them. Even with, you know, the most powerful microscopes, you have to do these pretty complicated techniques to to understand them. And even then, when you do, you sort of have to freeze them, and catch them in one moment. And so you don't see how they dynamically move, almost like if you had like one understand a robot, but you only had one picture of the robot, and you only got to see the arms in one location or the legs in one location, they have to sort of guess how it works. And so what volume could do is it can develop through simulations, a complete picture of all the different states of the protein. And by having that, it gives you an idea of places to attack to have a small molecule drug that can be used to, let's say, stop some protein that's doing damage, let's say a protein associated with the virus. And having those insights have been those insights have come out of the simulation, and then therefore suggest opportunities for new types of drug design. And so that's still ongoing, there isn't yet the sort of the final drug from their COVID work produced. But actually, they have done a beautiful job of being very transparent with how they've done and what, what compounds they're looking at. And it even speaks to kind of a whole new area, which is kind of bleeding edge, just the concept of an open source, a biotech of sorts, where everything is done collaboratively and in the open, and where the results would be, in principle could be collaboratively shared. That's been a dream of many people. And there's still some challenges with that, both legal and otherwise. But it's it's fun to see them pushing the envelope in that thinking as well.

Jake 32:47
Yeah, so I was reading a bit about this, and I couldn't help but you know, maybe in my like novice mind to connect this to like Bitcoin, just because of the decentralized aspect and the computing power required and everything like that. So I just figured I'd give it a Google search. And there was actually an article from coin desk in I think, 2013, maybe that was, basically I think the title was something like, should you be mining for profits or proteins? Yep. And they had a quote from you in there? What are the sort of parallels? And what just like doesn't make sense at all, when comparing something like this to something like Bitcoin? Yeah. So,

Vijay Pande 33:23
you know, really, the, the, the whole idea of Bitcoin was to try to create that distributed ledger that could be used for something like a currency. And, and so in that, you know, there's a central problem that they're solving for proof of work, you know, solving inverse hashes, one of the things that I was always trying to figure out is that, you know, it's kind of amazing that we have all of this compute power being applied to solving a problem, which is critical for sort of the logistical function of distributed trust and, and the crypto nature of cryptocurrency. But before sort of that much more powerful little solving something that is useful, and many of us have always thought about, is there could there be like a folding home related proof of work that you could insert in? It's tricky to do. And while I still have a few ideas that we haven't implemented, the the simplicity of the proof of work in Bitcoin, I think is key to its success. where maybe this gets interesting is just to realize that, you know, supercomputers get a lot of glamour, but the most powerful computers really are just collectively, all of the devices that we have sitting around us, and that that compute power is just enormous. And in that sense, that's where probably the two of them maybe have the most sort of deepest links. But what we do with them, and between the two is actually fairly different.

Jake 34:47
Right? Is there anything in terms of like your ideas for how we could possibly make the solving of the problems actually useful? Is there anything you can sort of share along those dimensions or maybe alternatively, Talk about why it's why it's so challenging to do something like that. Yeah,

Vijay Pande 35:04
I mean, I think it's the the challenge is coming up with problems that are really worth solving that can be solved in a uniform way that it fits for proof of work. And in the end, I think various proposals for things like proof of stake may end up being just simpler anyway. So probably inventing more creative proof of work schemes. There probably there hasn't been a lot of effort towards that. But you know, I think in the end a just to characterize the problem, just the space of problems, which would be obviously well associated with proof of work

would be something that is hard to solve, easy to verify, computationally, like, and so the inverse hash is a good example. It's once you have the answer, you can check it and everyone knows it's right, trivially. And so there are a few mathematical problems like that, that are much more useful that one can think about, but how to arrange into a cryptocurrency, all that stuff. I think that's I don't think anyone has really put the effort into that. And my gut feeling is that given the alternatives, it's probably less interesting. Although, you know, I would love to see it. I think my guess is that it probably won't move that way.

Jake 36:09
Yeah, that all makes sense. Last thing on the the folding at home project was there. I'm not sure if this connects directly, but there's a company that you co founded while at Stanford globe of your bio sciences, it was at a product that spun out of the finding the folding at home or something totally separate.

Vijay Pande 36:27
Yeah, is a finding of my lab using sort of infrastructure and things that were developed for folding at home. And so the results there were drugs for infectious disease, especially Dengue fever and Ebola. And I think at the time infectious disease was on our minds, because if you remember the builder crises, and there were SARS, I think there was a lot of us who had concerns that a pandemic could be very devastating. And that we were looking to see what were the existing areas infectious disease that we could make impacts on. And those were the ones at the time. I think, we probably wouldn't have guessed it would be in the end of Coronavirus. But that I think has been on many of our minds for for for years before, just because, frankly, I think there have been other pandemics before SARS is a normal example. It just didn't hit the US in the world in the same way. And I think people maybe you don't realize that this pandemic that we have now, there's unless the infrastructure cuts in there, there's no reason why something like this couldn't happen again, maybe not at this scale. But at a SARS like scale, like once a decade, or once every five years, and maybe at this scale, maybe once every 20 years. And so one of the key things I think that a lot of startups are trying to think about is how to build out that infrastructure, such that we can

address these things much more rapidly. You think about like what Madonna did so impressive that the design of their modern was built, like in many ways, like a tech company, and the design of their antiviral is done in two days, you know, essentially on a computer, took some time to roll it out. But it would be exciting to think about how we can sort of accelerate that global view, I think was trying to sort of think about the early days of that. I think since then, that topic, obviously has gotten more and more interesting.

Jake 38:19
Yeah, and it's interesting, you mentioned the moderna vaccine took, like a couple days to develop, and then several months to sort of get through the proper, you know, the FDA testing and things I guess, what are your general thoughts on, you know, like the FDA, and sort of regulatory, you know, inhibitors of of progress versus technological or, you know, expense related things that slow down the progression and acceleration of sort of progress in healthcare. I know, you mentioned how, like, I was reading one of your posts about how like, you know, Moore's Law intersects with Moore's Law, if that's how you saw That's right. And I knew that couldn't have been backwards, the same as more but, uh, but I think you're talking about how basically Moore's meets up with rooms. And, you know, technology sort of takes over for this, you know, opposite effect where healthcare is just getting more and more expensive. So I'm curious to hear like how you think about, you know, whether it's biology specifically or healthcare more broadly, developing over the next decade or two, and sort of the not just the technological challenges to get over but the regulatory as well.

Vijay Pande 39:36
Yeah. So, you know, I think the simplest way to discuss to describe the fundamental problem is that it's not a surprise to anyone, especially people living in the us is that the cost of health care is increasing rapidly as becoming a greater and greater fraction of GDP, like us, six to the fifth now, I think like 20% and and growing, growing exponentially, and so events like half of GDP, or three quarters of GDP are all of GDP, we're basically all of us are literally working in healthcare. And then it will be more than GDP, which means it's just unsustainable. And many people from people in

companies that people in government have seen this problem coming, and have been trying to think about what is the way to address it. This is a looming crisis, of which the again, the pandemic was maybe a little bit of a wake up call. But that it's that's the real crisis that's coming as the cost of health care. And, you know, there's a lot of reasons why health care is expensive. I think one of the I think most powerful arguments is that is that from what's called Bumbles cost disease, and this is largely the the concept that there are sort of some products that can be industrialized, like made in a factory, and some things are sort of bespoke. So if like anything that's bespoke, like getting a academic degree, or a lawyer or something like that, where everything is one off, the cost of that just will grow exponentially. And anything that can be made in a factory, like shoes, or you know, goods can can be decreasing exponentially like computers. And where this gets interesting is if we can shift from one curve to the other. And, you know, we've done this before, like before, there are factories making shoes, there are people making shoes, and those shoes are very expensive. And that if we still had people making shoe shoes with cost, I have a lot of money. And, you know, like the the factory shoes are not as good probably as someone who made a shoe exactly for your foot, we have to make some compromises, you have to be that set of sizes, and maybe you're in between a nine and a half and a 10. And you just got to pick one, but it's close enough, it's good enough, there's various things that you have to do to industrialize. But this industrialization of biology, industrialization of healthcare, is really in some ways, what it means to bring technology in to bring a sense of engineering. And that could be done through compute. And that'll be a large part of it. But it'll be other things sort of borrowing this sort of culture and thinking of tech how to make something 15% better year over year, you can just do that you get exponential growth. You know, and so I think that's the mentality that if people are trying to transfer into sort of making drugs and biopharma and into engineering, reengineering healthcare. And if we're right in the middle of that, I think we saw a huge advances that came just out of necessity that there was regulation for, for virtual care that if you want to sort of see a doctor over zoom, that doctor had to be licensed in your state. So in California, I couldn't have a Delaware licensed doctor see me over zoom, even though like he's a doctor, like I don't think Delaware has different

health than California, and the laws of health are different there. And so that got taken away. That was, in the end, I think, hindsight, maybe somewhat arbitrary for where we are today. And to the extent that regulations like that can be removed, I think that could really speed, the industrialization of things. And we'll start to see that. There are other things too, that I think this is a more controversial topic of what the FDA should be doing. I think nobody wants there to be drugs that hurt people. And so FDA testing for toxicity makes a ton of sense. In the end, though, the efficacy part is often effectively done by the people who pay for the drugs like the insurance companies, and real world evidence there for efficacy is actually critically important, because if you're going to serve, if an insurance company has to pay for drug A versus drug B, and let's say drug B is more expensive, they want to know, is it really better? Does it really help people more? Or are we just wasting our money. And that's something that they're very much geared up to do. And so it could be that through reimbursements, we can address and real real evidence start to address some of the issues that are now done through clinical trials. This alone is a fairly controversial topic, and people will fight to the death on this. And I think there are issues wherever you go, I think the challenge is almost like the classic trolley car problem is that you worry about hurting people through drugs, but you also have to worry about hurting people through not getting these things out fast enough. And how to balance that is, you know, one of these classic moral dilemmas. And these, the FDA tends to shift pendulums one way or the other. If you look at the history, it shifted in one direction because of thalidomide and the birth defects towards more regulation, and actually shifted away from regulation in the 80s with the AIDS crisis, because there were just patients dying of AIDS and they wanted to have it, they're going to die in six months. They said you know what, they want an experimental drug because they're gonna die anyways, and do that need there was a shift. So I think the FDA can be very, has been very responsive to these things. And I'm looking forward to them really making these types of shifts to address this modern era. If so, that speed we're talking about now could be greatly enhanced, and I think the answers in tech, like we've seen over the pandemic may start to even start to multiply up and we may make may make even more progress.

Jake 45:08
Yeah, that's a great perspective, I think another trend that I can sort of see coming that I've heard from, from people like yourself, that's sort of an exciting element to keep an eye on is sort of a shift from what is commonly called, like sick care, to more of like preventative medicine, preventative health care, like actual health care of, you know, maintaining people's health, and hopefully extending their health span a little bit just by behavioral type stuff, a really interesting chart I saw of yours, or I don't know if you made it, but you cited it, which was like, how I think 40% of overall, like premature death is caused by basically behavior, I might have the wording wrong, but something along the lines of like you're not born with it. And it's not like a symptom of the healthcare system. It's just like how you're behaving in the health

Vijay Pande 45:51
and the health care in that graph was 10%. So all of us healthcare, and all of drugs and surgery, and almost 10%, like genetics was like 30, or 40%. And 40% was the social determinants, so that math doesn't add up. So it was 10% 40%. And the remainder was, was genetics. But so, but that was the sort of shocking thing, and it's not a surprise, like if your spouse smokes, you probably either will end up smoking or getting issues lung disease, I think, if your spouse over eats, it probably will affect you. And I think the history of health care, people don't realize this is an issue of healthcare in the US is not some central planning, necessarily, but that it was a perk given to workers in the 50s, to try to get them to stay with the company. And that originally before, then it was out of pocket. And people would just deal with the doctors themselves. And then this perk came about. And that's largely why we have this sort of system where your, your job pays for your health care, because it arose from that. But because they're paying for these services, they're trying to minimize the number of services, not necessarily maximize your health. And and so that shift that you talked about towards value and really towards prevention, some of it sounds very boring, like, you know, eat better in the end. And it really is that we're back to psychology yet again, which is how can we empower people to do the right thing, because the wrong thing is easy. It's easy to sit, you know, on the sofa, and watch TV versus workout is easy to have desserts instead of being

thoughtful of what you eat, and how to flip it to make it easy to do the right thing. There. This is another place where I think tech is really interesting, because we see how much tech can change people's behavior. You know, just phones, we are addicted to our phones and the connections of it, to the extent that that phone can be a device to sort of modify behavior, maybe with some sensors that are less a measuring your body glucose or measuring other things, to give you real feedback and tell you you know, you got to be careful about this. There's all these new technologies emerging that when combined with the tech in a cell phone, I think can really change the sort of course for prevention. I've seen it with myself personally that what was it now it was about two and a half years ago, I got diagnosed with pre diabetes, heading towards diabetes. And I had to make pretty radical changes. And having that information early that came through, actually, when the portfolio companies q bio, that like that really sort of was the wake up call, and got me to change my diet, change my lifestyle. And actually, I love the change we made. But I didn't have the sense of urgency and then the knowledge. And so I don't know how to change the people's behavior and change the psychologies really the question. And we know tech can do that. The question is, how can we use tech to do it?

Jake 48:43
I think people at the beginning of this podcast, they will hear an advertisement from aura, who makes the ring which is, you know, something that I wear that I really enjoy. And then I also tried the levels patch for a month and had Josh on the podcast, I know you guys had their DFC bound a few months ago, super exciting company. And I'm going to definitely go and use it again, I just wanted to like do a mock trial, and then give myself some time and go back when it's a good time to experiment. Again, all of these wearables that help whether it's, you know, measuring your glucose or your sleep, or your fitness and activity, or you know, how what you eat affects you in other ways, potentially, all of these things, I think, like you mentioned, you know, it's hard to influence human psychology and, you know, change people's decisions in a way, but sometimes it's just a small push. And sometimes it's just having the data is what gets measured, gets managed type of thing. So I'm very optimistic and hopefully, you know, I'll be engaged on the cutting edge of all these

things that become available just to try to increase my own health span. The last thing I have to ask you about, I know we're running up on time, but speaking of healthspan one of my first guests on the podcast was Aubrey de Grey. I've gone on to have other people in and around the aging space from Ilan, who I think kolab the investment and Kristen's company was also aghast IO H, which you guys, you know, recently funded. I'd love to hear your overall perspective on the aging space. Given that I think one thing that you have said is basically like and correct me if I'm wrong, of course, but basically, it could be not necessarily it will be. But it could be that aging may be sort of the best pathway to cure diseases like Alzheimer's and cancer and heart disease, all of these sort of age related diseases where you could almost say that aging is is a cause of sorts that, in fact, you know, going after aging directly could be the way to solve all these diseases.

Vijay Pande 50:39
Yep. Yeah. So you're absolutely right, that the the science of epidemiology of this is pretty clear that the rate of onset of cancer of Alzheimer's, heart disease, many of these things, rapidly increases with age. And actually COVID is another good example of something that's really fundamentally an aging disease, that the the impact on the elderly is much more harsh than on on the younger. And it's, you know, it's no secret that we're sort of different than not nearly as full sort of power as we get older. And so that part's not, I don't think is all that controversial, I think the question is, like, how could you possibly do anything to sort of slow down the clock, or maybe even bring it backwards. And that's where aging biology is really interesting, because there's been so much fundamental science, trying to just understand how we age and what that process is, and actually studied in a lot of different other model organisms and other model organisms, you can extend their life dramatically. But you know, like C. elegans, I forget what it is, it's like 10 times longer or something like crazy. But you know, C. elegans is a worm, like a little worm that has, you know, in the end, not that much to do with the complexities of a human being. And so what could you possibly do with humans? It's interesting to study people who are older, and just understand like, Why do some people die, like at 120, and why others my diet 60 or 80, from natural causes, and so on. And you mentioned

bio ag so we actually led their series A several years ago, and and continue to invest in Kristin fortney, the co founder, CEO, she has these data sets that are really remarkable for people over many years, like decades, and to be able to draw from and use machine learning data science, to try to understand what are the elements that have allowed people to essentially live longer age effectively, age slower. And it's, there's still a lot of open questions. But I think, as a field, it's a very intriguing one. I think in the beginning, I think the early aspects of aging science will be used to identify targets for new drugs, and to go after diseases that have aging components of which COVID actually has one and by the way, he actually has a drug in clinical trials for COVID. But, uh, and so it will be really useful as novel biology define new targets. And that's within the standard sort of healthcare paradigm where drug design paradigm where you've learned some new biology, and that gives you some new place to look for, for designing drugs. But I think the blue sky area is where actually, we combine prevention and aging, where people prophylactically take some sort of compounds to slow down their aging. We're, you know, we're pretty far from that right now, other than the fact that people do this, maybe indirectly or not, or with the best they have, like, a lot of people take Metformin. To do this, people take an ad plus, to do this, I think in in the grand scheme of things in the fullness of time, these will be seen as pretty crude. But that in time, if you combine the the obvious thing that we want to help people just not get sick, and we want to help them stay healthy, longer with greater health span, bringing in the aging, the biology of aging is kind of a no brainer, it's like the obvious, it would be the obvious thing to do, we just have a lot to learn. Still, it's just early, this might be something part of like a 10 year 20 year arc to where we finally get to the point where this is a key part of prevention. But the fun part is that I think this is very much shifted from science fiction, to basic research towards some early drugs, and that there's a lot of work needed to be done. But that shift from like basic research, even to something where now we can use data science engineer these things that I found particularly compelling. I was particularly excited about where that means we could be especially in this sort of playing tech and Moore's law to things where we could be in 510 20 years.

Jake 54:54

Yeah, I totally agree. And I think just the fact that you said that it's gone from sort of science fiction to actually be Reasonable it's gone from crazy to crazy still maybe, but like feasible and you can sort of get there at least if you're hanging out with with the people in like the San Francisco culture, like we talked about maybe now, elsewhere, but but you don't you don't get just like a blank stare anymore if you talk about extending human health span by time 20 plus percent whatever it is. So yeah, that's great. And I'm very excited. It's interesting like for, you know, I'm relatively young, like for me, it seems that there's sort of, sort of, you know, factors that can be influenced that can lead it to being something that sort of happens during my lifetime or not yet. And that is pretty exciting. And part of the motivation for the podcast actually, overall, but anyway, vj, I really appreciate you coming on the show today. I know we're coming up on time. But thank you so much for for sharing your perspective on all these topics. been great talking with you. Where can people go and follow your your progress going forward? Do you want to send me to Twitter, I know you're on clubhouse a lot. And find,

Vijay Pande 56:01
you know, thank you for that. And thank you for having me. It's been a super fun chat and Twitter. It's just my name. Vijay Pandey at vj Pandey, they're one club Ocelot and those are probably the natural places