Hello, welcome to another Q&A about future of science and technology.
And I see we have a number of questions saved up here.
Let's see, Paula asks, if alien civilizations evolved their own computational worldview, how different would their science look from ours?
I think it's a long story that what it means to be an alien civilization. I'm kind of not… I'm a believer in the fact that there's alien intelligences everywhere, so to speak. The only problem is they're too alien for us to recognize them as being like us.
So, as I've commented many times, you know, people say the weather has a mind of its own. Which, then one can say that the kind of the physical processes going on in the gases in the atmosphere are just as computationally complicated as
the processes going on in the electrochemistry of our brains. It's just that what happens in the weather is not well aligned with the kinds of things that happen in brains and so on.
But, if one asks the question, what… are there different ways of… so, so, I think what's special about brains is
the fact that unlike the weather, where lots of different things are happening and they're all affecting each other, there's no kind of central control of things, in brains, one of the key things is that we ultimately have to decide what to do with our bodies, so to speak, at every moment in time. And so we get lots of sensory input in.
And then we have to decide, are we going to, you know, wave our hands around? Are we going to say this or that? We have to take all of that input.
Big stream of input, and sort of crush it down to a small sequence of actions to take.
And I think that's a feature of, kind of, the way that brain-like things deal with the world.
And I think that's… that's a… if we say, are there different ways that one can take, kind of, all of those details about what's happening in the world and crush them down into sort of a stream of experience and a stream of actions to take.
There's a good question, sort of, how… how are there different ways to do that?
So, for example, we might represent what's happening in the world by describing it with, let's say, human language, where we're, again, taking a large stream of data and sort of crushing it down to a sequence of words that we say. And the question of, well, are there different ways we can do that? The answer is very obviously yes for human language, because we've got a few thousand different languages in the world.
Although they have rather similar structures. But if we ask… if we try to make a computational representation of the world, which has been sort of my effort for the last 40-something years, what… are there different ways that we can make such a representation?
Well, I think the answer is…
For… for humans who've developed with, sort of, the cultural and linguistic background that we have, there's one set of answers.
For something which just has the similarity with humans, that one has kind of a description, a symbolic description of the world.
but it doesn't have any of the sort of shared history of our actual human language and so on. There's a somewhat different answer. And I think there are certainly many ways one can imagine constructing, kind of, the description of what, sort of the symbolic representation of things. One thing for us is we're very big on the idea of a stream, a one-dimensional stream of things.
that can be sort of laid out in time, said word after word after word in sentences, or whatever else, or read in text in a book, or something like this. We're very big on that sort of very

sequential kind of thing. We also certainly can use, and I've spent a lot of my efforts using diagrams in two dimensions, to represent things, and, you know.

one often might say, you know, a picture is worth a thousand words, and if a well-made diagram can communicate a lot, that's sort of a different form of communication. I think

So far, it has been, probably… the idea of sort of making a symbolic representation of things has been very much emphasizing the analogy with language, which tends to have this kind of one-dimensional character. Language also has this whole formation of sort of subclauses and this kind of tree-like structure. That's a thing once captured for computational language as well. There's a question of whether one could do the same kind of thing, where sort of every program is a picture.

And where, instead of having a program which is sort of written out as a sequence of characters and tokens and so on, one has something which is an array of such things on a page, and a couple of questions. One is, would humans understand it?

And the other is, how should it be constructed? Mathematical notation has some degree of two-dimensionality to it, whether it's subscripts and superscripts, or the structure of matrices, or something like this.

And in fact, many years ago now, 30 years ago now, we extended Wolfram language to be able to deal with the kind of two-dimensionality that exists in mathematical notation, and that works just fine. It's a little bit…

kind of, set up again so that it is sequentially readable. I mean, when you say X squared, people sometimes, when they're dealing with tensors for things like general relativity, tensors can be, you know, R mu nu, zeta, psi, sigma, or something, and there's sometimes a convention that people will say, kind of,

The indices can be written either as lower indices or as upper indices, contravariant or covariant indices. Some people will do the slightly funny thing of reading them in kind of low voice, high voice, to represent whether they're… whether they're sort of downstairs indices or upstairs indices, but again, there's quite a lot of sequentiality

to it. It's somewhat rare that you have sort of two indices on top of each other, although that has a perfectly well-defined meaning in tensor analysis.

This whole question of, of, kind of how you best represent Oh, things like two-dimensional, two-dimensional forms, those are not… it's not so obvious how you read those things. I mean, do you read them across left to right, one line after the next? Do you read them down in columns? How does it work? Sometimes, if you try to actually communicate these things in a sequential way, sort of the sentences are too long, and it's very hard to keep track of what's going on.

an experiment I tried, oh, 15 years ago or something now, when Wolfman Alpha was young, and, we were first, providing Wolfen Alpha for things like Siri. There was a question of, sort of, how would, in a voice-based system, how would one get these kind of long sequences of data read in a way that wouldn't, make people kind of fall asleep or

lose track of what was going on, and at that time, had a bunch of experiments we tried to do with, kind of, injecting, sort of, pseudo-musical components into this, into this kind of, sequence.

of, of kind of reading, you know, reading a table of data with little beeps and so on, or little, things where you go sort of high-pitched and fast for part of it, if it's sort of a footnote, and so on.

But, you know, this question of whether brains like ours can understand information presented in different ways is

is sort of one part of the issue. For example, when you see a graph, a network.

when it's very simple, it's probably quite easy to understand what's going on. Maybe it's something like a flow chart, a decision tree, something of that kind. But if you're presented with this 50-node graph where everything's connected to everything, very few humans can understand well what that means.

I don't think I'm one of them. It just looks like, you know, a ball of wool. You can't really tell what's happening.

And one can imagine a kind of a form of mind that can immediately sort of untangle that network and sort of immediately understand what it's about. I think we don't manage to do that very well because we are so sequential in the way that we do things. We're kind of taking in information from the outside and kind of crushing it down into the sequence of actions that we take through time.

I, I think, that's,

But, sort of a… one could imagine, sort of, another kind of intelligence, an AI of some kind, which can take, kind of, those kinds of networks and somehow immediately have an understanding of them. It's worth noticing that, although there are

so-called graph neural networks, the vast majority of what happens, well, in neural networks, again, has a lot of sequentiality to it. It tends to be the case that, with, for example, transformer nets.

One is with transformers, one's… one's going, sort of, what's the next token, based on previous tokens? And that's something that, is a thing one… one kind of looks at, even for things like images, which you would imagine would be things that are sort of very two-dimensional. Vision transformers tend to go, sort of, sequentially, sort of scanline after scanline, like an old-fashioned analog television does.

So, but, I mean, I think this whole question of

what are the primitives with which one can build one's worldview? Is it sort of sequential kinds of things? Is it things like networks? What kinds of constructs are there? Those are…

all interesting questions, and the way that our particular, kind of biologically structured brains and our particular sort of cultural and linguistic development has gone is one direction. It might not even be the only one that's possible for human-like

minds, I don't think we really know that at this point. I mean, there's a quite different question, which is, in human history, if

certain things had been invented in a different order, what would have happened? And certainly the one that I'm always curious about is if

computation of the kind that we think about today, like being able to set up sort of rules for a machine and having the machine automatically implement them, if that had become commonplace a long time ago in the sophisticated in a fairly sophisticated form, how would that have affected intellectual development?

You know, as it… as it was.

at the time in the 1600s, when mathematics was becoming sort of a popular way of thinking about the world, there was certainly… that was, I mean, a date to remember in science history is 1642, which is the year that Galileo died, Newton was born.

and Blaise Pascal, developed

a mechanical calculator. He wasn't quite the first person to do that. The first ones have been a few decades earlier, but he made one that has survived, and that was… that was all happening in 1642, and I think that

the,

the way the actual engineering of mechanical calculators was not such that you could get them to do very sophisticated things at that time, nor was there an understanding of a motivation to do that. It was just, we're trying to do arithmetic, we can do that with an abacus, we can do that counting on our fingers, or we can use some kind of mechanical device to do that.
Had there been more of an understanding and more development of kind of the idea of using mechanical devices to implement rules and go a long way with implementing rules, I think perhaps some of science might have developed a bit differently. I mean, when Babbage was imagining the analytical engine in the 1830s and so on.
there was, you know, one… imagine these sort of giant, steam locomotive-sized kinds of things that were churning out kind of computations that never, in fact, got developed at that time. Had it been developed, I think there might have been a slightly different intuition about what
Was sort of the way to think about the operation of the world.
I mean, I think that, it's an interesting quote from Descartes.
in, oh gosh, when? The 1620s, maybe? Not sure. Sometime in the early 1600s, where he says, you know, one day we may understand a tree as we now understand a clock.
So, a clock for him, clockwork was a well-understood thing by that time, had been for a couple of centuries, although there'd been precursors even in antiquity. But, you know, a clock was a thing where the clockwork, the cogs, they fit together. There's a sort of sequence of, in a sense, rules that determine how the hands of the clock move.
and Descartes
was imagining that one day, I think maybe he said even within 100 years, one will understand the operation of a tree as one does the operation of a clock. In other words, that there would be a kind of mechanism to a tree as there is a mechanism to a clock.
Now, that idea didn't…
so much persist. It became, for the exact sciences and physics and so on, it became sort of overwhelmed by this kind of idea of using mathematics and kind of the power tool of mathematics
And mechanism was something that certainly was discussed, particularly in areas like biology, but more so as biology developed into the 20th century and so on. But the idea that one would have sort of a mechanism, program-like description of lots of kinds of things predated the time when one thought one would have a mathematical, you know, Newton's Law-type description of things.
And had it been the case that those kinds of laws were implemented beyond clocks and into more, like.
computing kinds of devices, I kind of think that the idea of thinking of the world in computational terms and thinking of programs as sort of raw material for making models of the world might have developed much earlier.
and might have actually been the dominant form of modeling for lots of kinds of systems, instead of the idea of using continuous mathematics and calculus to do that. I mean, certainly my own efforts in the 1980s on using kind of this computational way of modeling the world
That could have happened a great deal earlier, and probably would have happened a great deal earlier
If there had been sort of more ambient experience with this notion of computation from actual practical computational devices.
Let's see…

Let's see… There's a question here, if you could ban one buzzword from future science, what would it be?
You know, a few years ago, probably 2017 or so, on April Fool's Day that year, I wrote a piece about, I called it buzzword convergence. It was about, I forget the order, quantum neural… blockchain AI, or some… some permutation of those words. And actually, it was kind of, I thought, an interesting piece, because I was kind of explaining some of the intellectual commonality between those different areas of the way that a lot of them have to do with, sort of, many inputs.
one output, notion of attractors and things like this. But in any case, the,
It tends to be the case that lots of… lots of science and technology and many things is driven by, kind of, the message that's delivered with a buzzword.
In science.
What's a, what's a buzzword that, one doesn't like?
I mean, I suppose… The quantum buzzword gets added to many things, sometimes deservedly, sometimes not.
I mean, I was, And sometimes what people
think of as… I think the one that I've been noticing recently is quantum biology, which was kind of at one time thinking about the effect of quantum mechanics in biology, but now seems to have generalized to be sort of just sort of future thinking about biological systems. Maybe I'm wrong that that generalization has generally happened, but that's a case where it's very confusing. Because, quantum has a definite meaning, and it's, it's not that meaning. Now, the same thing has happened to some extent with AI. People, some things where people say, I'm going to use AI to do this.
they really mean I'm going to use computation in some way.
The… the… historically.
sort of AI, when it originated in 1956, was something which it's like, we're going to get brain-like things to happen, but we imagine we're going to get brain-like things to happen through sort of a generalization of logic, through a generalization of something formalized.
There was already thinking about neural networks, but it was more kind of the… we're going to do sort of symbolic reasoning, and that's going to be the way forward that allows us to use machines to do sort of superhuman intelligence-like tasks.
what AI has come to mean in the last decade is neural net AI, or to many people, that's what it's come to mean, which is this kind of statistical approach. You train a system with lots of existing data, and you say, go extrapolate to what you can get in the future.
And I think that's, and now it's very confusing, because people are saying, we're going to use AI for science.
And, you know, what does this actually mean? Does it mean we're going to use a neural network and try and train it on lots of existing science and have it figure out new science from that?
Or does it instead mean we're going to use something computational to do science in a way that's sort of innovative in some fashion?
I think it is coming to mean that second thing, which is more the kind of thing I've been doing for many decades now, unless they were just going to feed all of science into a neural net and have it take over from the scientists and go on from there. And it's often very confusing, because people will say things like, we discovered this with AI.
And what that often can actually mean is we did a computation where we enumerated lots of possibilities, and we picked out good ones, maybe using some AI-like heuristic, or maybe just

using good old-fashioned, did it fit this particular pattern computation. So that's a place where, kind of, it's becoming very confusing. What does one mean by AI? Does one mean this kind of train from examples, neural net type approach, or does just one… does one just mean, sort of, computation as a… as a methodology in general?
I suppose another thing that one might complain about in a buzzword for,
Future of science would be the term science itself.
I think the term science itself has become sort of a brand for, this is knowledge you can't dispute. It comes from science.
I do think that was an original idea of Francis Bacon back in the day, of, kind of, if we tell them it's from science, they won't dispute it from the 1500s. But that's also a thing of today, that, you know, people feel like if it… if I can say it's scientific, it comes from science, it's kind of a, oh, then it must be right. Now, a confusing thing, if you think about the naming of things
fields, The… the fields like physics.
Biology, they don't have the word science tacked onto the name of that field.
fields like economic science or something, or maybe, well, earth science, perhaps a more… I don't know, some… the areas that sort of were already a thing
And then needed to feel like they were becoming… becoming more science-y, and physics has sort of been the gold standard for science for a long time, and maybe deservedly, maybe not, in some ways deservedly, because a lot of, sort of, big towers of consequences
Have been figured out in physics, and they actually work.
But it's sort of a confusing thing that when people want to legitimize some area and say, yes, it's really a science-y area, just add science to its name. And I think
Then the notion that, you know, we proved it with science becomes kind of the, you know, you can't dispute it.
Now, I mean, I have to say, I've been, particularly, probably in the last decade or two, increasingly frustrated with things where people say, you know, the expert scientists have said this or that.
And the fact is, if you actually talk to the expert scientists and you ask the right questions, you… they will tell you, well, yes, you know, you can get that result from some model, but it's all rather complicated, and, you know, there's a lot of footnotes to that claim.
And to say that's what the science says is, is really, somewhat misleading.
And, so I suppose in terms of buzzwords for the future of science, the buzzword that I think perhaps is most challenged in some places is the word science itself.
And it's… sometimes it is used, sort of, as a way of papering over the lack of, sort of, foundational understanding of what's going on, and it's just like, well, you know, it's… it's what was done from science.
Kind of an ironic twist on that question.
Let's see… Oh, boy. Some Itz is asking about some…
says there was an article about Google looking for UK experts to find uses for a new quantum chip. Do you think it's difficult to find interesting use cases for quantum computers? First, you have to make a quantum computer that actually means something. I've talked about this a bunch before. I mean, the big thing of quantum mechanics
Is that whereas in classical physics, sort of definite things happen, in quantum physics, many paths of possibility are followed, and then at the end, in sort of traditional quantum mechanics, we just get to say the probability of what happens.

If you could make a quantum computer, the way you would make it is by having those… using those many sort of threads of history in parallel to do many computations in parallel.

But then at the end, the thing that is the most difficult is knitting those computations together to come out with a definite answer so that you, as a human can say, yes, I got the answer. As opposed to, there are all these things which are possible answers and possible computations going on on the inside.

Our brains expect definite answers. We can't make use of, oh, there are all these possibilities. That's… that's not how we tend to set things up.

So, you know, the challenge for quantum computing, there's sort of that one, well, maybe two types of computations that a traditional quantum computer, seems to be potentially able to do well. Factoring integers, doing various kinds of searches, but these are both things where

Those were both algorithms that were invented in the 1990s.

And sort of the idea has been, you know, is there going to be sort of a way to use the magic of quantum mechanics to use those algorithms to be able to do computations much faster? It's proved to be very difficult from an engineering point of view, and what's ended up happening

The practical side of it is people have been trying to figure out how to make computers out of things other than electrons and semiconductors. That's a perfectly valuable pursuit, figuring out how to make computers out of trapped ions, or cold atoms, or superconducting junctions, or whatever else. It's not necessarily very practical for your average laptop, but it's certainly an interesting direction for the future

For physics, and for sort of thinking about future computers.

The, the question, though, is if you actually want to do a practical computation, how does that really work?

And the thing that tends to happen is, well, there's lots of noise, there's lots of, sort of uncertainty in the results coming out from quantum computers, and there are various efforts to do error correction and so on, essentially sort of locking together different pieces of the output, so that instead of sort of everything flopping around separately, you've made this rigid object that sort of all flops together, so to speak.

as a way to sort of try and lock down to prevent, kind of, the noise that is sort of a symptom, I think, of the difficulty of kind of deducing sort of the one final result from all these possible intermediate results.

So, there are different sort of methods for making a quantum computer to kind of work

by using different pieces of physics, by sort of leveraging different pieces of physics to do your computation. So, one thing to do is to make things that are like logical gates of the kind that are used in a standard computer, like ANDs and ORs and things like that, or generalizations of those that work in quantum mechanics. Another approach

is to say, I'm just going to set up this configuration of things, and I'm going to try and find, sort of, the minimum energy configuration, the optimal configuration, kind of like you set up this landscape, and you're asking, where's the lowest point on the landscape? That's sort of a different type of quantum computing.

And there are other things that sometimes get…

somewhat confusingly called quantum computing, that are really quantum sensing technologies where you're trying to find very accurately the magnetic field, or something like this. Those are really a separate kind of thing, and I think they have much more immediate application. When it comes to the quantum computing side of things, there are these different

modalities of, you know, you're computing, like, logic with gates and so on, and you're computing, set up this configuration, find its minimum energy.
Both are difficult to do in practice. The second one is probably a bit easier to realistically get something out of in practice.
But yes, it's a… it's a, figuring out, you know, how can you make use of this
kind of,
the technology that exists, and sometimes it's as much… it's a good way of generating noise, and for some kinds of simulations, you want to generate lots of noise, lots of randomness, and so you can use it for that. I mean, a somewhat ironic thing is the use of quantum computers to simulate quantum systems, and it's like, well, what exactly does this mean? You know, the quantum computer is a quantum system.
What it means is you've got a particular quantum system you're interested in, like a molecule or something, and you want to use this general quantum computer, you want to set it up so that its behavior will correspond to the behavior of the molecule.
for example, we'll simulate the molecule, and it's as if you've got, oh, I don't know, let's say some whole arrangement of levers and springs and things like this.
and you want to simulate an object that has, you know, a single lever and a single… well, two levers and two springs, or something like this. You say, well, I can hook up the levers and springs in this big thing that's an array of lots of levers and springs.
to make use of… to be just like the thing that is just two lovers and two springs. And that's the same kind of thing that you're trying to do when you make a quantum computer simulate a quantum system. And that seems like a somewhat… somewhat promising thing to do.
I mean, I think the,
This, this question, this approach of, we have a hammer of a certain kind, let's go look for nails that we can… that we can hammer with that… with this kind of hammer. This is a thing
that has been not so common in the history of technology, actually. Different companies have adopted, sort of, methodologies of things somewhat affected by whether the company's main objective is to produce things that, sort of.
That make money by being sold to people, or whether the main objective is to do things which sound cool enough that their stock price will go up.
That sounds very cynical, but that is a realistic distinction of different kinds of companies. And if the objective is of the second kind to do things that seem cool so your stock price will go up, then having sort of things where you've got a hammer, some misshapen hammer of some kind, and you just spent
You know, a billion dollars building that hammer.
And now, it's like, we've got to make this hammer, you know, sing and dance for the public, and, be something where people will be like, wow, they built that hammer. And so the best strategy is go try and find nails.
And I think it's become slightly amusing in the AI business that, lots of people… a big net has been spread of, you know, contact all these scientists and mathematicians and so on, and ask them to, sort of
for example, make up problems that can be solved by AIs, but really, a large part of that story is make up problems that can be solved by an AI. So, you come up with a problem, and if the problem sounds interesting enough.
then you can crow, look, my AI managed to solve this problem.

I think it's a… it's not particularly useful if one's trying to understand what is the scope of the types of problems that AIs can solve, because you kind of went searching in this giant field for a nail that happens to be, you know, bashable in by this particular hammer.

That sounds very cynical. I think I'm… I'm sounding very cynical today, I'm sorry.

the… Let's see…

Rohit asks, what do you make of the recurring motif among 20th century theoretical physicists leaning in the direction of Eastern philosophy?

Well, I mean, again, in my…

cynical streak here, I could say that as the number of physicists increases, the probability that people will touch all different areas of culture also increases, but I don't think that's the main point.

I think… that, they're a… kind of…

Ideas about the nature of reality, that…

have existed in Eastern philosophy for a long time that sort of speak to, among other things, the relationship between the… the sort of inner observer and what is in the outside world, what is… what is sort of

Going on outside, and that somehow has a resonance with quite a lot of what one's learnt in physics about, sort of, the separation of

The observer and the observed, whether that's in relativity, of thinking about, sort of, how observers can think about simultaneity, whether that's in quantum mechanics, thinking about what observers can actually observe over the underlying quantum processes, or in more recent times in my own work, kind of, what

the… how observers perceive things like the Rulliad, and perceive, sort of, large amounts of computational irreducibility. I mean, I tend to think, and I know less about Eastern philosophy than I would like.

But I tend to think that there's great resonance between these kinds of ideas about the importance of the observer as a thing that is imposing, kind of.

the way that the laws of physics are perceived, and the way the laws of physics… the laws of physics that one perceives, the fact that the observer is a sort of participant in presenting, in leading to the laws of physics that we actually perceive, I kind of think that that's something which has some resonance with long-discussed ideas in Eastern philosophy.

And I think that's… it's that type of thing, that the increasing recognition of the observer as an important part of the story of science is perhaps what's led to that… that interest. I mean, I think one of the things one sort of hopes about science, perhaps, or hoped about science in its early… early times, is that it's very objective. It doesn't matter what the observer is.

Well, what's become clear from what I've done, for example, and from precursors in the development of relativity and quantum mechanics and so on, is, well, actually, the observer matters. The… not the observer in detail, not the every whim of the observer, but

The general character of the observer, the fact that the observer is at a particular place in spacetime, the fact that the observer has a certain size, the fact that the observer can't do certain levels of computation.

Those… the coarse facts about the observer turn out to matter a lot in deducing very precise science. And that's something which I think, perhaps in Eastern philosophy, there's a little bit more detail of the observer that's thought about, but still, the notion of the importance of the observer, I think, is one that's there.

Let's see…

Will asks, if you were building a new house for the future, what would you do or prepare for? It's an interesting question. I, I am…
the house that I'm in right now, we built, what was it, 22 or 3 years ago. And, it's… the challenge at that time was, what kind of cabling should you run in the walls? Should you run
you know, Cat5 Ethernet cable, should you run, various kinds of,
telecom cables and so on. My one contribution to that thinking was just run empty conduit in the walls, empty pipes, and you can, and leave, sort of, pieces of string that you can… fishing wires that you can pull things through those, those pieces of empty conduit. That's worked pretty well. Haven't had to open up any walls, at least not for that reason.
It's been possible to just, you know, when there's a new type of fiber optic cable or something like that, just pull it through the conduit and that works.
Now, I have to say, when we built this house, for example, the computer that I used was a nasty, noisy computer.
And so, I had set it up so that I could have my office with my nice desk, and it would be very quiet.
And the room next door had the computer that was making a loud noise, and there was some elaborate sort of run of conduit through the floor and so on to get cables, the sort of high-frequency cables that you need for displays, which have a big length limitation, to be able to just about get them, snake them through the floor, and get them to the big noisy
computer.
Well, now the, the computer just sits behind my desk and it's absolutely silent. So that was, that was something that became unnecessary to do there. I would say that the,
this whole question about, sort of, the, the house of the future and, the sort of increasing automation, when we were building this house 22 years ago or so, it was, kind of,
it was interesting at that time to see the different efforts that people have made to automate kinds of things, like, you know, you wave your hand to make the lights go on, or you wave your hand to do this or that thing, and then you'd see videos of people who were doing these complicated, essentially, dance moves in front of their televisions and things to get them to do different kinds of things. That UX has gotten progressively better over the
years. I think the thing that is always surprising about,
Sort of devices in houses is, in the end, there are wires, and there's electrical supplies, and things like this, and in the end, it's a sort of contractor-style
activity to go install this stuff. It's not, the only thing that isn't like that is anything that's wireless, and I suppose the number of things now that one can control from one's phone is much larger. I mean, it was the case that, you know, there were lots of control panels that you would put in in a house, and now those things are mostly apps that you go to on your phone.
I will say that I think, sort of, the very fancy light switch thing, which has
in general, not been a big success. I think it's often just easier to, you know, flip a light switch on or off. Maybe that's my own fault in the case of the particular house I'm in here, because, you know, very elaborate set of sort of complicated light switch configurations, which included the not-so-brilliant idea of mine that one would have double-click mean something different
From single click, because that allowed one to increase the number of possibilities on a keypad of a given size.
I mean, I think that the, those are…
those are… so, I mean, this question about how much… so the automated house, what it looks like, and how much of that one can do, is,

there's a question of what's… what's important there, and how much, you know, elaborate control should there be? I mean, I think with… with smart

devices, it feels to me like some of that has come and gone. I mean, I remember maybe a decade ago, going to the Consumer Electronics Show and seeing, you know, every refrigerator had sort of a camera inside and sort of lots of smartness to it, and that doesn't seem to have become very popular.

I think… in,

You know, there are other things that have kind of come and gone in home automation. I would say, well, in terms of the construction of houses, you know, having robot vacuum cleaners, that's kind of a win, particularly if your house is set up so that the robot vacuum cleaner can have a happy time and doesn't just get stuck all the time.

And I suppose if one was building a house, I don't know whether one should build one's house

For the, for the robot vacuum cleaner, it seems like one should build one's house for oneself.

And one should assume that the robot vacuum cleaner will get progressively smarter. I mean, there's a big push, which we'll see how it comes out, towards humanoid robots.

As… and one of the use cases is kind of the home robot.

humanoid robots tend to be kind of a good form factor for robots, because the world that we live in as humans has been built so it works for humans. You know, you have stairs that you can walk up with two legs and so on. You have doors you can open with a hand and things like this.

And I think, insofar as the world is built for the human form factor, having robots that have a human form factor, they're going to be sort of plug-compatible and fit into that world.

And then the question will be, if you have a home robot.

you know, what should your house be like so that you best can service your home robot? My feeling is, don't worry about it too much, because the home robots will necessarily develop to do things that are like what humans do, because that's what the market is, so to speak.

And so most things that you would set up for humans will work for the humanoid robots. I mean, I…

I think,

That's, that's another kind of thing. I mean, I think that, it's,

Yeah, I'm noticing some comments here. The,

from Tony, about motion sensors for lights are an upgrade.

They say, yeah, maybe. I mean, how many times you've been in a room which has motion sensor lights, and you're sitting there, you know, quietly by yourself, and the lights just turn off?

And then you have to wave your hands, and the lights go on again. And it feels very, kind of druidic, that, it's a very, sort of… and maybe there's a way to be smarter than that. I mean, I know,

in iHouse, we put motion sensors everywhere. It's kind of interesting to be able to see, kind of, the motion sensor profile of the house over the course of 20-something years.

And you can kind of see different parts of the house got used, more or less, as children got older and disappeared and so on. It's, you know, different usage patterns and such like.

I had at one time tried to figure out these algorithms for, can you figure out how people are going from one room of a house to another with motion sensors to solve the problem, among other things, of you're sitting quietly in the room and the lights go off. I never managed to figure out how to solve that problem. I'm sure you could solve it with an actual vision system that's actually, you know, recognizing people walking from here to there, but with pure motion sensors, I couldn't figure out how to

how to deal with that.
Yeah, I think there's a… there's a comment here, another comment here from Tony about, underfloor heating and so on, and, the… having, kind of, water pipes under… under your stone floor or something that, deliver heat.
Yes, that's… it's kind of cool, a bad word to say, given that you're talking about heating. Yes, I… this… our house has some of that. It's,
Maya…
I mean, I think that's a… that's a fine thing. I will say about HVAC in general, heating, ventilation, air conditioning, that, I've always been surprised at how comparatively little that domain has advanced. I mean, there's been a push to advance it because things like refrigerants have gone out of style because they have all kinds of environmental… the older ones have all kinds of bad environmental consequences.
And so there's been sort of a push, I don't really know actually the details of those consequences, but there's been sort of a push for new refrigerants that's kind of forced a certain obsolescence of a certain amount of HVAC equipment.
But in terms of how do you really control these things, well, it's kind of a thermostat. And the thermostat can be a fancy thermostat that has a nice display, or it can be just a plain old thing with a lever that you move to make… to change the thermostat. But how does the thermostat actually work? Well, it's a control system.
And what does the control system do? Well, it's opening… it's switching, you know, you basically get to switch on a heater, switch on a chiller, open event, close event.
those are the things that systems do. Now, you can imagine some very elaborate future system that has some kind of no moving parts, you know, electrical way of guiding things and so on, but that's not how HVAC systems, even high-end ones, seem to work right now. They are… they have a very coarse set of controls of it's either you're putting in heat, you're putting in cooling, you're, you know, whatever.
Then the question is, well, how do you control such a thing? And the obvious issue is, if you're trying to hold a certain temperature, and you say, well, if it's… let's say, if it goes below that temperature, switch on the heat.
If it goes above that temperature, you try and pull down the heat with cooling, well, if you don't do that very carefully, you have a sort of disastrous situation, because you're oscillating right above the set point, and you keep on switching things on, switching things off, and it kind of cycles all the time. In actuality, the most common thing is a so-called PID controller, which kind of integrates
Some of the error term from how much, sort of, below or above you were the set point, and it tries to sort of smooth things out.
Now, you know, you can be more elaborate in doing those things. Actually, I was thinking a number of years ago of using Wolfram language, because we have a bunch of control system capabilities, to finally, as I hoped, fix the HVAC system for my house.
But I never got around to doing that, and some simpler fixes were found that didn't involve doing that. But it's sort of interesting that the core technology for that, I don't think, has really advanced much in a long time.
I mean, there are things one can do
that, involve more kind of predicting what's going to happen and so on, and I suppose there are some places where one can do that, but the final, you know, hold this set point temperature, I don't think has advanced much.

I think,

Okay, Tony is suggesting, I think, for lights, add a heat sensor. Okay, that's an interesting idea. That's not something one usually does. An infrared,

I mean, the, the motion sensors are, sometimes ultrasound, sometimes infrared, but I don't think the idea of, is there a person in this room? Let's find out by seeing whether there is a, you know, 98.6 degrees Fahrenheit, or a little bit, or whatever, thing in the room.

I guess the question then is, do the cats, if you have them or something, you know, do they get the lights on or not? Are they enough of a source of, source of heat, and so on? And then, the question is, if you're, presumably, the,

the ultimate heating that's going into your room is not body temperature, because that wouldn't be very pleasant, so probably that wouldn't confuse things. I haven't heard of people doing that. Seems like a reasonable idea.

the, Let's see…

I'm trying to think about other things about houses, and you know, another thing that's sort of a… question about houses as displays. I'm… I'm not a television watcher, so I don't really… I'm not really into having lots of, sort of, televisions to watch things everywhere. But, while I tell a story from a long time ago, a previous house we were renovating, oh gosh, what was it?

30 years ago now. The,

I was, my wife was trying to figure out, you know, there was some complicated configuration of things where there would be a 4-inch deep niche where you could put a television, and the question was, is a television going to fit in a 4-inch deep niche?

And I was like, yes, I've seen flat-screen televisions, they're coming any day now. Well, actually. As my wife reminds me sometimes about predictions about the future, well, they didn't come for another 10 or more years after that time. It was sort of interesting, because I'd seen flat-screen televisions, they existed.

The problem was that you couldn't manufacture them in bulk.

Because there tended to be defects, manufacturing defects, and if you're making a memory chip, and there's a defect in one part of the memory chip, you can always kind of route around that defect. But if you have a big screen, and there's a defect in one part of the screen, it's super annoying, because that part of the picture is frozen. And it took a long time for the yields to be enough that you could actually routinely make

large flat screens. So, kind of, if you were prepared to get the one in a thousand flat screen that came out perfectly, then you could get them a decade earlier, but if you wanted to get, kind of, the consumer thing, it took a lot longer. But I think that's one thing that one sort of imagines is coming, is almost the, you know, paint the display on the wall type thing.

I mean, and, expect that you could have every… every part of every wall be kind of a… a smart wall, so to speak. I mean, I…

you know, there have been precursors of that technology for 30 years or more. Is that a desirable technology? I'm not sure. I don't know if that's, you know, change a wallpaper every day type thing. I don't know if that's desirable.

I mean, it has to be said, one thing that I thought about doing many years ago is setting up kind of a video conferencing wall

and I've seen some people have done this now, where you can have sort of half of a conference room in one place, and half in another place. You can have kind of a conference room at your house or something, where you sit down on one side of the table, and there are other people on the other side of the table at a completely remote location.

it is tricky to get the optics to work out right. It's like, how do you actually get a camera that will be able to, sort of, be able to, sort of, display things the way that you would see them if you were actually sitting in the room, and so on?
I mean, it's a… it's a,
sort of a famous example of this is something like Star Trek, where they're always showing this sort of the, you know, the crew of the Enterprise are talking to somebody else on this big screen. You know, if you work out the angles, it couldn't work that way. You know, there isn't a camera you could put that would make the thing sort of actually display it that way, and I think the same is… it's a… it's a challenging thing if you want to make the…
half a conference room in one place, half a conference room in another place. But that's something, maybe, as you can kind of have
a larger number of cameras and a larger display surface, that's something that probably becomes possible. You know, other things that people think about in houses, one question is, are the rooms square, or rectangular, or whatever? Or do you try and have something where you have sort of a rounded thing, or some complicated shape?
I know many architectural experiments have been done with kind of more complicated shapes of rooms. My impression is they are not very successful. My impression is, well, it doesn't help that furniture tends to be made to fit in square rooms or rectangular rooms, but it seems like people don't really like those things very much. And that's, you know, it's a complicated thing, whether it's kind of nature or nurture, that causes people to like certain architectures.
architectural forms are not like other architectural forms? Is it just that we're used to a particular thing, or is it that there's something in our nature that makes us, kind of feel more comfortable with that? Or is it actually something intermediate that's kind of nurture from nature, in a sense? Where it's because of our experience of seeing things in the natural world, that if we see something, you know, if we see some kind of structure in a piece of architecture where we're like, that couldn't possibly stand up.
And it makes us sort of feel a bit uncomfortable about it, whereas if it looks like it's been… it's been set up in a way that nature might have set it up, where it will be very solid, that's a… that's a more desirable thing.
I think, the,
the thing that, so, you know, there are these ideas, like, you know, let's… let's do a very different kind of thing for, let's say, the shapes of rooms. Same thing with chairs.
You know, there have been times when there's been a sort of a big enthusiasm for a different shape of chair, you know, kneeling on them, doing this or that or the other. The truth is, we humans are a certain shape.
And, you know, so it tends to be the case that… that things that we discovered a long time ago kind of more or less work. Sometimes technology intercedes, like
your typical office chair of today is, is something much more comfortable to sit on for a long time than the thing that was there in the past. And that's, you know, that's… that's one piece of, kind of, definite progress.
I would say, I'm trying to think about other things that, are sort of features of houses. I mean, I think the most significant thing probably coming to houses in the near future is probably humanoid robots, if that works out. And it will certainly be,
it will be curious if there are things that turn out to be unexpectedly difficult for humanoid robots to navigate. There'll be sort of a strange situation of, you know, oh, everybody, instead of when they have young children, you know, putting up gates across the stairs, you know, there'll be

some other strange thing in houses that will be like, oh yes, I put this net here, because otherwise my humanoid robot

You know, kind of,

falls downstairs or whatever else. I don't know how that will develop, but my guess is that the humanoid robots will end up being able to navigate the environment in sort of the same way that humans can.

There's a comment here about, humanoid robots… what was it?

About, I think it was about providing power for humanoid robots.

let's see, couldn't find it, but I think somebody was asking about providing power for humanoid robots, and that is… that has been traditionally an issue. I mean, it's always… you see these robots, and people say, this is an amazing humanoid robot.

There are two things to look for, of sort of the hacks of humanoid robots. One is the knees aren't straight.

Because when you do inverse kinematics, you do the kind of, try and calculate the motion of robots, there's sort of a singularity when you lock your knees, or when the robot locks its knees, and so people often try to avoid that by having the knees slightly bent. That's one hack.

The other hack is, look in the back of the robot, and look at how big the power cable is that comes out of the robot.

That's, and sometimes, you know, you have this dancing humanoid robot, but the secret fact is it's drawing this huge current to run all its motors and so on. My impression is, last few years, the kind of actuators you need in robots have been getting to use a lot less power, and batteries have been getting better, and it's more and more realistic to have a sophisticated, you know, 200 degrees of freedom robot

That, doesn't have the great big cable coming out of the back.

Effer asks, would you trust to have a humanoid robot in your house?

It's a good question, but I think the answer is,

I… you know, I suppose it partly depends on how strong is the humanoid robot.

I mean, in other words, if the humanoid robot could…

readily, sort of, come and crush you or something, that's one thing. If the humanoid robot is such that, worst case, you pick the thing up, or you

you know, sort of push it away or something like that. It's a bit of a different thing. I mean, it feels like having a big tortoise in your house where, you know, truth is, you couldn't lift the tortoise if it's a giant, you know, Galapagos tortoise or something. But still, I don't know how much you worry about that in

as a thing to have around. I mean, I think in terms of…

I mean, there are all sorts of things that will surely come

Whether to humanoid robots or to augmented reality and things, like, one very obvious one of home relevance is visual diffs.

you walk into a room, and the question is, what's changed here? You know, that, oh, you need to put this away. Well, where did it go away? Well, I can see where it was yesterday, and, you know, I can know to put it away in that place. That's a thing that, one can imagine being, would be a good thing. Trulia is commenting, maybe a cat robot or dog would be better.

You know, there's a funny history to that. Sony made this AIBO dog years ago, and the robot researchers who were making that would have found it much easier to make a six-legged creature. And, it was, the problem was, from a marketing point of view, the six-legged kind of giant cockroach, you know, kind of robot.

just didn't seem nearly as attractive as the robot dog. I think that,
the concept, I mean, certainly the form factors of quite a few robots have been kind of dog-like, and some of these robots that, you know, carry packs.
for, for military applications and other kinds of things like this have been kind of dog-shaped, and, I think, I don't know what,
The question is what the utility of the robot is going to be. You know, does a dog… a dog, notably, doesn't, you know, doesn't have hands to pick things up.
And a lot of, kind of, home robot tasks, which are human-like tasks, involve picking things up and doing things with them, rather than just being there and, you know, barking at things and so on.
Let's see… Oh, yeah, here's a question from, Took.
About solving the problem of power supply to humanoid robots.
Let's see…
Memes, comments, painting an interactive thing on a wall makes me think of the Looney Tunes Wile E. E. Coyote painting a fake tunnel on a cliff face.
The Roadrunner runs right through in the Koeti… Koyote smacks into it face-first. That's amusing. Well, it is certainly,
It would be a very strange thing. I mean, for example, if you've got this thing on the wall, and it's like, is it a mirror, or is it the right way round?
that's a… that's already a confusing thing. I mean, that's something that's dealt with with, smartphones when you… when you flip the display around. But, one can imagine, gosh, what a… what a… what a… you know, all sorts of strange issues with having,
you know, and again, as you say, as it becomes more realistic, there's more tendency to walk into the wall type thing. You know, no doubt.
yeah, I don't know what,
you know, there are usually cues on, you know, big mirrors and things like this. There are cues from, sort of, the framing around it and so on. This is a mirror, rather than, you know, just walk straight through it.
Hills asks, would your ideal at-home robot have wheels or legs? It's gotta have legs. There's no, you know, there are enough things
Built in the world of houses that assume you have legs, whether it's stairs, whether it's thresholds for things, whether it's even getting on a ladder.
That, you know, that's… it's got to emulate what we have, I think, to be sort of plug compatible with the environment that we… that we've set up for ourselves.
Let's see…
I have to go soon here, but let's see if there are more. It's a good,
talking about future houses is… is kind of interesting. I think,
You know, one of the challenges always with putting technology into a house.
Is, because it's often, you know, contractor-type.
you know, construction-type, type stuff. You put it in once.
And 25 years later, it's still gonna be there. And it takes…
significant effort to upgrade the thing. And certainly, if you have to sort of open up the walls and things like this, you've got a whole giant, giant adventure going to be able to make any upgrades.
I mean, I have to say that I think the biggest thing with houses probably coming when there is sort of real breakthroughs in robotics is the cost of construction.

And the fact that, you know, some of the cost of construction is materials, but a lot of the cost of construction is labor. And it's, you know, and as time's gone on, you know, houses just have more and more elaborate stuff in them that's more and more elaborate to build in.

And one has to believe that if one could have, kind of, lots of robotic work done on that, and you have a giant swarm of robots that descends to construct a house, and they're working on it 24-7 and so on.

And and then…

That, first of all, one can do more elaborate things in the construction of houses, one can, and second of all, there are really bizarre things one can imagine, like, it becomes economical to have a house, take it down again.

Rebuild it in another place, things like this that we would never imagine possible, given the current cost of construction.

the,

I think, Artem is commenting, people… perhaps people should try making an insect or a small fish robot first, just like nature made them first, and only move on to more advanced creatures later. I think…

that… that was the order in which biological evolution could construct things. I kind of think once you know the answer of you want a biped with hands and fingers and so on.

that it's probably at least as easy to sort of go in that direction. I mean, there have been a bunch of experiments I've seen on both fish robots and insect robots.

they are… I mean, I think insect robots, just like in the science fiction movies, are often for various kinds of surveillance purposes, of, you know, you can have the little tiny thing go and surveil someplace, maybe even without getting noticed. The fish robots.

are… well, it's a question of what are they going to be useful to us? Again, it's sort of a surveillance, or delivering something purpose, or going and interacting with the fish.

Purpose, but it's kind of like, what is a fish robot going to do?

I mean, a home robot, a home humanoid robot, does what it, you know, can do things which are immediately compatible with the things we humans want to do. A fish robot, well, it can be in your swimming pool. I mean, it's a very common thing these days to have robots that are kind of like, you know, the analog of vacuum cleaners for the surface of a… of a swimming pool. But I don't quite know what the,

what the fish robots, what we'd use them for. I suppose, yeah, I'm actually having a hard time thinking of what a fish robot would be, what the use case for us humans would be for a fish robot. I mean, if the, you know, if in some future time, you know, the civilization of the, of the whales or something develops, then

No doubt they'll be much more into having fish robots.

the, maybe I'm missing something there, but, but, I'm, I'm not, not seeing a, yeah, Twitch is commenting, deep-sea exploration, for sure. I mean, that's, although, in a sense,

you only… you know, that's a you-only-do-it-once type thing, probably. I mean, it's like we don't have… it's not like you could say, well, we could have, you know, jungle exploration being done all the time by drones. We don't.

We have, you know, one survey every, you know, whatever.

And, Hill's comments, underwater tunnel digging, maybe. I kind of think that ends up being a giant industrial machine that gets, you know, lowered and then drills the tunnel. I don't think it's… it's,

I… the idea of… of the robotic fish that is kind of chewing its way through the, through things doesn't seem all that realistic to me, and I suspect a lot of time when it's dealing with bedrock, and you're dealing with explosions and things, and then maybe the robotic fish gets to place the explosion… explosive material, but I don't think otherwise. It doesn't seem obvious to me that it has a particular use case. I mean, I suppose you can imagine a situation for… for exploration

where, you know, if you could have an autonomous robot that would fit through the cracks, if there… I don't really know, I don't think there are so many cracks. I think that unless you're dealing with, you know, a hydrothermal vent or something like this, I think the ocean floor is just… is covered with… with some kind of silt or something. I just think… I don't think you go into it particularly. I mean, I have to say, in terms of robots of exotic locations.

the, the robotic earthworm has always seemed like an interesting one to me, being able to kind of go underground and surveil underground, by, by some method of kind of, sort of, eating your way or drilling your way through, through soil and so on. Why is that relevant? It's relevant in cities where people started laying down

all kinds of cables and wires and so on, you know, 130…

150 years ago now, and nobody knows where those things are. And when you say, I'm gonna… I'm gonna dig in the city, it's like, whoops, well, you might destroy this electrical cable that was put there, you know, in 1892 or something. And so that there's a reason to want to explore that way.

The other thing, is for archaeology, it will be wonderful. There are many modern cities that are built on sites that have been in use for 4,000 years, let's say, and I don't know, thinking of, I don't know, Athens or something like that, it would be quite wonderful to be able to sort of have your robotic earthworm go and explore under, you know, and find the layers, archaeological layers.

from, you know, the 6th century BC, or something like this, and be able to go and find the artifacts from that, and that would be sort of an application of the… I don't know what one would call it, the, terabot or something that kind of goes through the ground.

All right, well, with that, thanks for all sorts of interesting questions and prompts there. I should run off my day job, but thanks for joining me, and look forward to chatting with you another time.

Bye for now.