

Naval

Dec 22 2021

The Beginning of Infinity, Part 2

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Part 2 of my interview with [Brett Hall](#) about [The Beginning of Infinity](#). Also see [Part 1](#).

With a Good Theory of Knowledge, You Can Decide What Else Is True

David Deutsch's theory is centered around good explanations

Naval: [David Deutsch](#) has this great view of the world where he believes that everything important is understandable by a single human. By important he means the underlying base theories that drive most of reality.

Deutsch fixates on four theories. I could argue maybe there are a few more, especially if you start getting into Adam Smith and [The Wealth of Nations](#) and a few other more sociological ones. But he's obviously a physicist concerned more with reality and truth-seeking, not human systems.

The four he picks are the theory of epistemology; the theory of evolution by natural selection; quantum theory, into which he subsumes relativity and other physics; and the theory of computation, which includes his theory of quantum computation.

These four are fascinating. It's probably worth exploring what's interesting about each of them. What is the breakthrough here that might be nonobvious?

Let's start with [epistemology](#).

The reason I love [The Beginning of Infinity](#) is that Deutsch does a very rigorous review of what is correct in epistemology, what we know to be the best answers. Once you have a good theory of knowledge, then you can decide what else is true.

If you're starting with a bad basis for the theory of knowledge, then you're going to decide on a bunch of things that are false when you think they might be true.

And his epistemology is centered around good explanations. It takes [Popper](#)'s view of science and truth-seeking as being error-correcting mechanisms and expands on it. I'd love to hear your summary of the theory of knowledge, or epistemology, as Deutsch lays it out.

No Truth Can Be Justified

'Knowledge' is just our best guess at the time

Brett: Initial guesses at what 'knowledge' was all about amounted to what is known as the "justified true belief" vision of knowledge, and it's still the most prevalent idea today. Anyone who calls themselves a [Bayesian](#) is a justified true believer.

This is the misconception that knowledge is about trying to justify your beliefs as true. And if you've done so, then you can say, "I know that thing." If I can justify as true my theory of gravity, then I should believe that theory of gravity, and only then can I say that it's known.

The problem with this is that there is no method of showing any piece of knowledge is true. The improvement Deutsch promotes in his books is this vision that Popper gave us, that all we have are guesses about reality. They're conjectures.

People think, "Oh, that sounds a bit wishy-washy. It's just a guess." Well, it's not a random guess. It's a guess that has stood up against trials, against attempts to show that it's false. It's not that everyone who decides to have a guess stands on equal footing.

When people are unable to show that something's false—via this method of refutation—then we accept it as a piece of knowledge. This allows us to accept the fact that we're going to be able to make progress in the future, because all of our knowledge is conjectural. All of it is our best guess at the time.

There's elasticity within the knowledge that allows us to say, "There's going to be errors. We're going to correct them and, thereby, be able to make progress into the infinite future."

This is unlike the previous conception of knowledge, which says, "Once you've justified something as true, well, it's true." If it's true, that means there is nothing false about it and, therefore, it can't possibly be refuted. That's a very religious notion.

The modern incantation of this is Bayesianism, which says, "You have a theory, you collect more evidence, and you become more and more confident over time that your theory is correct."

It gets a little bit worse than that, because then it says, "This Bayesian reasoning enables you to generate new theories." Which it can't. The best that it can hope to do is to show you that you are more confident in this theory than you are in that theory.

The Popperian view says, "If you can show that there's a flaw in a particular theory, you can discard that theory."

There Can Be No Final Theory of Gravity

All we have are better and better approximations to reality

Brett: In almost all cases, you only ever have one theory on offer.

In the case of gravity, there literally is only one theory on offer at the moment. There's [general relativity](#). Previously we did have two theories. We had [Newtonian gravity](#) and we had general relativity—but we did a crucial experiment.

This idea of a crucial experiment is the cherry on top of science. You've got these two competing theories. If the experiment goes one way, one theory is ruled out but the other theory is not. In which case, you keep that theory for so long as no problems arise.

This vision of knowledge enables us to have an open-ended quest for progress.

This is completely unlike any other idea about knowledge. The overwhelming majority of physicists are still Bayesian. And the reason they're still Bayesian is that this is typically what's taught in universities and this is what passes for an intellectually rigorous way of understanding the world.

But all it is is what I would call species of scientism. It's because they have a formula behind them, the [Bayes' theorem](#), which is a perfectly acceptable statistical formula. People use it all the time in perfectly legitimate ways. It's just that it's not an epistemology. It's not a way of guaranteeing, or even being confident, that your theory is actually true.

My favorite example of this: Prior to 1919, every single experiment that was done on gravity showed that it was consistent with Newton's theory of gravity. What do Bayesians say in that situation? They say you're getting more and more confident in Newton's theory.

How does that make sense? How do you square that the day before it was shown to be false was the day when you're most confident in it?

Now, a Popperian doesn't have this problem. A Popperian says, "At no point was Newton's theory actually true. It contained some truth, but that truth isn't a thing that we can measure."

I say it contained some truth because it's certainly got a more direct connection to reality than some other random person's guess about the nature of gravity. Gravity does indeed approximately vary as the inverse square law, but not exactly. We needed general relativity to correct the errors in Newton's theory of gravity.

And even though general relativity is our best guess right now, it can't ultimately be the final theory of gravity. There can be no final theory of gravity. All we have is better and better approximations to reality.

Naval: I think the reason we fall into Bayesianism so easily is probably related to why we fall into pessimism so easily. We're evolutionarily hardwired for Bayesianism.

Every other animal on the planet that can form good explanations is a Bayesian. They're just looking at repeated events and saying, "The sun rose yesterday. The sun will rise tomorrow." Or, "That thing I touched is hot. It's probably going to be hot in the future." That is how most of our biological systems and most of our evolutionary heritage worked.

It's just now we have this neocortex that can form good explanations about the seen in terms of the unseen. That gives us a higher level of reasoning, but that higher level of reasoning is not instinctual to us. It requires effort. It requires deep thinking.

We default to Bayesianism because that is how a lot of the natural world around us seems to work at least at the purely biological level.

Genetic Evolution Was a Prelude to Memetic Evolution

Ideas undergo the same evolutionary process as genes

Brett: Popper has a book called "Objective Knowledge," and it's subtitled "An Evolutionary Approach." And that's no accident, either. There's a symmetry between the theory of epistemology and the theory of evolution as we understand it.

Before we understood what is known as the Darwinian theory of evolution, the only idea that people had was that these entities had to be created. All the plants and animals that you see around you had to be created by a creator. There was no other explanatory mechanism.

Some people came up with the idea of gradual change over time. Lamarck was one. His idea was the reason why giraffes have long necks is that their ancestors had slightly shorter necks, so they tried to stretch their necks to reach the leaves they couldn't reach.

But again, there was no mechanism for this beyond the fact that an individual goes off to the gymnasium and works on their biceps and their biceps get a little bigger over time. Although you can work out in the gym and increase the size of your biceps, that doesn't mean your children are going to inherit those characteristics.

What Darwin came up with is a similar idea to what Popper had in knowledge. It was an error correction. The idea is that an organism would trial itself out in a particular environment and if it wasn't, as we say, fit for that environment, then it would die off. But if it was fit in that environment, then it would survive.

So you have this encounter with reality between living organisms and the environment. And it's the environment that's giving you feedback from reality and destroying those organisms that aren't fit enough to survive.

The Neo-Darwinist view is to give us what the unit of selection is. It's not the group or the herd; it's not even the individual. It's the gene. It's the selfish gene idea, which comes to us from Richard Dawkins, who says if any one of those genes happens to be not fit for the particular environment, that could cause the death of that organism. The species might survive, but its entire DNA will ever so subtly change over time as the environment changes.

Now we have leveled that up. We human beings are the next step in that evolutionary process where we can create explanatory knowledge, which does the same thing. Deutsch likes to say, "Genetic evolution was merely a prelude. What's coming next is memetic evolution."

The history of the universe from here on out is going to be the history of ideas undergoing the same evolutionary process as the genes did previously.

Humans Are Exceptional

Humans aren't just a form of bacteria that overran the planet

Naval: Three out of these four theories have an interesting pattern to them. With good explanations in epistemology, we're saying conjectures and their refutations and error correction is how we improve knowledge. With genetic evolution, genetic mutations, variation and natural selection weed out the ones that didn't work. Then there's memetic evolution on top of that, where we have ideas and then criticism weeds out the ideas that don't work.

Related to that, in invention there's trial and error. In capitalism, startups get created and the ones that have bad ideas fail. We see this pattern recurring over and over.

What's interesting, though, is there's another metapattern here, that humans are exceptional. In epistemology, humans are the only non-Bayesian reasoners. In evolution, humans are the only memetic creatures that we know of. In the [theory of computation](#), humans are the only universal explainers that we know of other than, of course, the computers that we've invented.

Science took us from this view of humans being at the center of the universe to, "Actually, humans are nothing special. You're just one little planet out of an almost infinite number of [Kepler planets](#) that could be bearing life out there." But the three of these four theories that we're talking about are pointing us in this direction of humans are exceptional. Humans are capable of maximal knowledge.

One interesting realization for me was that even if you were God, even if you had infinite knowledge and power, even if you controlled the entire universe, you still wouldn't know that you're not in a simulation. You still could never prove that you're not in the simulation. And even as God, there is no concept that you could hold in your head that a human being couldn't hold.

Unless, of course, the laws of physics are different. If the laws of physics are different, then all bets are off and who knows? But working within the current laws of physics, humans are capable of maximal knowledge and maximal awareness. That points to a world where humans are exceptional and not just another form of bacteria that got out of control and overran this planet.

A lot of these fundamental theories lead to a viewpoint that humans are special, knowledge is infinite, and as long as we don't destroy the means of error correction and we're always creating new knowledge, then there's good reason to be optimistic.

We Are Qualitatively Different From Other Species

There is no continuum between humans and chimpanzees

Brett: You're pointing out a minority opinion there. I think culture is still stuck in that second part of what you were saying.

Originally we thought that we were at the center of the universe. This was the religious conception of man's place in the cosmos. Earth was surrounded by the celestial spheres and everything orbited around it. So we were the inheritors of the entire universe, and God had gifted us with this.

Then science showed us that, in fact, we're not at a particularly special place in the universe. This is the cosmological principle, this idea that the universe is roughly the same at every single place and we are just one of those particularly unspecial places.

Not only are we unspecial in the cosmological sense, but biologically we're nothing particularly special, either. We're just on the continuum between bacteria to cockroaches through to dogs and chimpanzees.

An astrophysicist I absolutely love on almost every other topic, [Neil deGrasse Tyson](#), was talking about how chimpanzees are a lot smarter than we think and how we might not be much better. This is what almost everyone thinks.

This third view that a lot of us are trying to promote now is that it's not a slight quantitative difference between chimpanzees and us. There is a continuum between bacteria to cockroaches to dogs and chimpanzees, but we're off-axis.

We are qualitatively different. All we need to do is open our eyes. You look out your window at that beautiful city that happens to be out there that cannot be explained by this gradual increase of biological complexity.

More Compute Power Doesn't Produce AGI

Even the most powerful computers can't answer 'why?'

Naval: The artificial general intelligence crew gets it completely wrong, too: "Just add more compute power and you'll get intelligence," when we don't know what it is underneath that makes us creative and allows us to come up with good explanations.

People talk a lot about [GPT-3](#), the text matching engine that [OpenAI](#) put out, which is a very impressive piece of software. They say, "Hey, I can use GPT-3 to generate great tweets." That's because, first, as a human you're selecting the good tweets out of all the garbage that it generates. Second, it's using some combination of plagiarism and synonym matching and so on to come up with plausible sounding stuff.

The easiest way to see that what it's generating doesn't actually make any sense is to ask it a follow-up question. Take a GPT-3 generated output and ask it, "Why is that the case?" Or make a prediction based on that and watch it completely fall apart because there's no underlying explanation.

It's parroting. It's brilliant Bayesian reasoning. It's extrapolating from what it already sees out there generated by humans on the web, but it doesn't have an underlying model of reality that can explain the seen in terms of the unseen. And I think that's critical.

That is what humans do uniquely that no other creature, no other computer, no other intelligence—biological or artificial—that we have ever encountered does.

And not only do we do it uniquely, but if we were to meet an alien species that also had the power to generate these good explanations, there is no explanation that they could generate that we could not understand.

We are maximally capable of understanding. There is no concept out there that is possible in this physical reality that a human being, given sufficient time and resources and education, could not understand.

It's Mind Blowing That Our Minds Can't Be Blown

Humans can understand every idea given enough time and effort

Brett: Scientifically minded types say, "Perhaps we won't be able to understand the next set of laws of physics. Perhaps we won't be able to understand the aliens." It's nothing but the appeal to the supernatural. It's logically equivalent to "God is out there, and you can't possibly understand what God is. God is this infinite, omniscient being that is beyond us."

You can believe that if you like. You can believe the simulation hypothesis. You can believe any one of these things. They're all metaphysical claims about a reality that we have no access to. Whether or not you want to introduce aliens who will have ideas that we can't comprehend, that's all standing on the same footing.

Naval: At least in God's metaphysics you could say, "OK, that's in a different universe. That's outside of our laws of physics." But the aliens presumably would be under the same laws of physics, so I don't even see what the basis for that is.

Any species that is smart enough to get off its home planet knows that the limiting factor is ideas. So the thing that they should want the most from any other species they encounter is new ideas. And the trade that they should be making is the trade of ideas.

There's this [Malthusian](#) philosophy in science fiction—now called the [Dark Forest Hypothesis](#)—that every human species is like bacteria and we're going to run out of room. No, the universe is infinite in size; it's expanding. The multiverse is even more infinite in size.

We are at the beginning of infinity. We're not running out of resources. Everybody's creating ideas. Smart alien civilizations trade ideas and successful human civilizations trade ideas. Because those ideas take things that were useless before and turn them into resources.

Every alien civilization can trade ideas with every other civilization because they're all universal explainers. They're capable of maximal understanding.

In fact, the mind-blowing thing here is that your mind cannot be blown. There's no idea out there that your mind cannot absorb given the time and the effort.

So if we encounter an alien species, we should probably rejoice. They don't want anything from our planet other than our ideas. And the best way to trade ideas is to have a dynamic, abundant, thriving civilization.

Because I grew up on rote sci-fi, I used to be pessimistic about alien encounters. "Oh yeah, if we encounter aliens, they'll just destroy us." Like, in [Hitchhiker's Guide to the Galaxy](#), the Vogons thoughtlessly demolished Earth to make room for a hyperspace bypass.

The reality of it is that any species that finds us is going to immediately give us all the knowledge that they have. And they're going to crave new knowledge that we have, because they will realize that would allow them to light up the dark matter, the dark energy, the unused resources in the universe, to allow them to thrive as well.

Where Are the Aliens?

The universe should be teeming with aliens

Naval: Let's talk briefly about the [Fermi paradox](#) since we're talking about aliens. For listeners who don't know, [Enrico Fermi](#) was a famous physicist who was part of the [Manhattan Project](#). He said, "[Where are the aliens?](#)"

The universe is so large and there are probably so many planets that are capable of supporting life of some kind or another. Shouldn't we have seen them by now?

Brett: Around almost every star there is a contingent of planets much like our own solar system. The number of stars that exist within a typical galaxy like the Milky Way is something like 200 billion, although the estimates go up to about 400 billion. The number of galaxies that we can see is around 200 to 300 billion.

The observable universe is just a small fraction of the entire universe, which means that the number of planets is absolutely astronomical.

Surely, given these numbers, it has to be the case that there are not only planets out there that are suitable for life but that the universe should be teeming with civilizations far more advanced than ours, less advanced than ours, and some that are similar in advancement to ours.

So where are they?

Intelligent Species Have Risen Only Once on Planet Earth

Creative intelligence wasn't inevitable

Brett: Now, that's one argument, and we have to be humble in the face of uncertainty here because no one knows. But I want to give an argument that rarely gets any air time.

The argument is that we are alone.

The argument has nothing to do with astronomy; it has everything to do with biology. The argument goes like this: Look at planet Earth and look at the number of species not only that exist right now—millions of them—but also the number of species that have ever existed on planet earth, which is hundreds of millions.

Life arose something like three and a half billion years ago, and for about two and a half billion years there was nothing but bacteria. So life apparently doesn't have much impetus to evolve quickly beyond bacteria; it just remains as simple as possible.

A lot of people have this misconceived idea that Darwin really did away with—the idea that evolution has a direction in mind. You see these pictures of evolution that appear in high school textbooks of the monkey that's hobbling around on all fours; then he's hunched over; and then eventually he is standing up and holding a briefcase, as if this is what evolution had in mind. It only seems to be what evolution had in mind in retrospect, by looking backward.

There's an American academic, [Charley Lineweaver](#), who calls this the "Planet of the Apes" hypothesis—as in, if you remove the humans from a planet, the apes would naturally evolve to fill the intelligence niche.

He said you could imagine another situation where you're an elephant that is able to think about themselves. They reflect on the length of their trunk, and they look back through biological evolution and see that trunks get ever shorter. So what they conclude is, "Ah, evolution has been geared towards making ever-longer trunks. That's what evolution is all about."

Of course, we can see that that's ridiculous. It just happens to be the case that this creature called the elephant has evolved and it's got this long trunk, but the length of the trunk doesn't appear to be a convergent feature of evolution.

A convergent feature of evolution is a feature that exists within biological entities that has arisen again and again, independently. Wings are my favorite example. Fish have wings of a certain kind. There are flying fish. Butterflies have wings, so we've got them in insects. They arose in mammals as well, with flying foxes and certain kinds of possums. And, of course, birds and dinosaurs had wings as well.

Independently, in all these species, the wings keep arising. So do eyes, and so do organs for sound.

Now let's think about the capacity to do mathematics or to build radio telescopes—in other words, to be an intelligent, creative species. How many times has that arisen in the geological history of the Earth? In one species and one species alone.

Can we conclude on that basis that, therefore, it's inevitable that intelligent species will arise? If you were to repeat the experiment by sprinkling a few bacteria around all the bio-friendly planets that exist throughout the universe, would you be guaranteed to get an entity like us?

The Probability of Human Existence Is Infinitesimally Small

From an evolutionary standpoint, it's near impossible

Brett: Here's another way to think about it that is mathematically frightening for the people who think that the aliens are out there and they're going to visit us sometime in the future.

We were talking earlier about trillions of planets that exist throughout the known universe that might even be friendly for life to arise. Imagine that between us as intelligent human beings and the most simple form of bacteria that we can imagine, there are only 100 independent evolutionary steps. Now that's not true—a million or more different mutations probably had to happen to allow the organisms to survive such that we exist today—but let's make it only 100.

Imagine that each of those independent steps had a probability of just one in 10 happening. Now, in fact, it's probably more like one in a million, but we'll be generous and say one in 10.

Now what we have is a chain of probability: one in 10, times one in 10, times one in 10...100 times. This is one over 10, all to the power of 100—which is one over one followed by 100 zeroes. That number swamps the astronomical number I was talking about with planets earlier on.

In other words, the probability of us arising in this particular argument is infinitesimally small. The fact that it's happened once should blow our minds.

If You Can't Program It, You Haven't Understood It

Evolutionary algorithms don't produce living beings

Brett: These are all uncertain hypotheses, but we also have to keep in mind that there's so much about evolution by natural selection that we don't know.

David Deutsch has this little quip, "[if you can't program it, you haven't understood it](#)."

In the case of AGI, this means we can't program it because we don't understand this idea of general intelligence.

The same happens to be true of evolution by natural selection. There are things called [evolutionary algorithms](#), but this is not programming evolution by natural selection. This is not being able to create artificial entities inside of a computer that, when subject to actual environmental pressures, are able to evolve towards this increasing complexity.

Aliens Might Just Be Too Far Away

We may not be alone in the universe, just too far apart

Brett: We still have this problem of what DNA was doing for that approximately two and a half billion years—the overwhelming majority of the history of life on Earth. Why didn't it evolve at all during that time? What's going on?

There's a book, [Rare Earth](#), by Peter Ward and Donald Brownlee, and these guys talk about all the quirky things that happened in the evolutionary history of the Earth. I just picked on the fact that we universal explainers evolved seemingly fortuitously, seemingly once; but you can go back and realize that evolving from single-cell bacteria to a multicellular organism was weird and unusual and hasn't been able to be repeated in a laboratory setting.

Then to go from the multicellular organism to something that's like a plant and then something that's like an animal—each of these things seems to have occurred for reasons that we don't understand.

Naval: There could be a combination of things going on. Your argument can be statistical rather than absolute. We may not be alone in the universe, but becoming universal explainers might be so rare that when you start multiplying that by interstellar distances, which are quite vast, we might just be too far apart.

I think Fermi also had the unreasonable assumption that interstellar aliens would figure out how to get past the speed of light, when we have no hypothesis whatsoever as to how that might be possible. We have nothing even vaguely in the category of how to get past the speed of light.

So if you're limited by the speed of light, and if the jump to universal explainers is rare, then we might just be too far apart. And it might just take a lot longer.

The universe is very big, but it's also almost entirely empty, at least as far as planets and the stars are concerned. Given that, it's still quite reasonable to say that humans and human-like explainers are quite rare; they're still early in their formation across the universe; and they're just spread out by such incredibly vast distances that we haven't encountered each other.

If we did encounter each other, I think we'd know.

For example, by the time an alien spacecraft got here, their radio waves would have arrived long before. There's a pretty long period in a civilization's history when it invents the radio and starts to broadcast radio waves out, before it invents interstellar travel and it's sending rockets and civilizations around the universe.

Aliens Would Visit for Knowledge, Not Resources

The only thing they will lack is the knowledge they don't have

Brett: I think Stephen Hawking said that it was a mistake to broadcast radio waves out into the universe because the aliens are going to be out there and they're going to be like conquistadors. They're going to want to take over our planet for their resources and various other things.

There's a couple of responses you can have to the idea of evil aliens coming to get us.

The first is that the only way to make progress into the infinite future and to have the technologies that would enable you to traverse the galaxy, is to have this vision of knowledge that Popper had—namely, that you are freely able to explore the space of ideas, able to falsify assumptions, and don't have centralized authorities and force being used on people, which dampens down creativity.

To have a maximally creative society, you have to have freedom, you have to have liberty, and therefore you will have a non-violent society. You'll have a society that values creativity as an end in itself.

When we encounter the aliens, we shouldn't expect that they're going to be immoral bastards that are going to want to take over our resources, but the opposite: They're going to look at us and think what primitive savages that we are. They're going to think that we're moral midgets, and they're going to want to teach us. They're not going to want to put us in prison or anything like that.

Knowledge is a unified whole. If their physics are so much better than ours—which enables them to approach the speed of light or to use some weird general relativity gravity thing that creates a wormhole, so they can get through space faster than the speed of light—all of their scientists are going to be so much farther ahead. All of their knowledge is going to be farther ahead: their mathematics, their morality, their political institutions.

So we don't have to worry about the aliens.

And, by the way, we don't have to worry about them stealing our resources. It's not like they're going to go, "Ah, there's a planet full of coal and water. We're going to take it."

No, they're going to have the knowledge to be able to sweep up the hydrogen in intergalactic space and turn that into a fusion reactor and use 3D printing to create any technology that they want.

In fact, that might be another answer to the [Fermi paradox](#). They don't need to leave their local area because they've already got the technology to perfectly sustain them.

Naval: They've got [Dyson spheres](#) and they can gather all the energy they need. They can gather all the matter, they can create anything they want, and they can have any reality in VR space that they want.

The only thing that they would be lacking is new knowledge that they don't have.

Ideas Are the New Oil

All the new fortunes are created with ideas

Naval: Humans have a history of conquest because we fight for the same exact resources, but even in human history the first explorers were traders. They were going out there to find spices, gold, silk, new plants to domesticate, new animals.

They weren't going out there necessarily to conquer the land. Eventually they did because of the finite resource dilemma when you're stuck on Earth. But the moment you have the technology to get off of the earth, finite resources go away.

If you want a resource, then you go find a neutron star or you go find a star system. You don't go after a little planet. There are infinite Kepler planets out there that are going to be much closer to them.

It's ideas and trade that people want.

If you look at modern society—even though I know this is not the common belief—we're becoming less warlike as we become more civilized. The reason is that you don't conquer Russia anymore for its natural resources. The wealthiest places in the world now are the ones that have the best ideas. Silicon Valley was on top for a while as a wealth creation engine because it had the best ideas.

The new oil is ideas. It's all digital. All the new fortunes are being created in ideas space.

In fact, if you're starting out today as a young, ambitious person, you don't learn real estate; you don't learn coal and oil mining; you don't go into the extraction of physical resources to create wealth. You go into ideas space. You go into programming, books, movies, blogs and podcasts and building robots, which are mostly intellectual property underneath.

Even as a human civilization, we're moving away from conquering physical resources and moving much more into trading of ideas.

The downside scenario for the human species is that too many of our larger countries and nation-states believe that they've achieved maximal ideas and now it's time to save resources. They end up destroying the means of improvement, error correction and creativity, and they end up stagnating.

Then you have the idea generation coming out of a much smaller set of city-states, which then have to defend themselves against these massive, more predatory, ossified states.

People talk about China being so impressive—"look at their rocket," or "look at their GDP," or "look at the city that they built." Call me when they invent something new. Call me when they come up with some incredible idea that we haven't had and they built some technology that we haven't had. Because so far it's all imitative. It's them taking advantage of technology they've picked up from us that they're now catching up on. They're just applying scale to it because they have more people.

Call me when their GDP per citizen crosses ours. Call me when they come up with pharmaceuticals or vaccines or spacecraft or energy generators or fusion reactors that we do not know how to build. Call me when the authoritarian society figures out top-down how to build something brand new, when it's more creative, when their art is better, when their science is better, when their technology is better.

Call me when that happens over a democratic, free, capitalist society, because I've never seen a case of that, ever.

One Einstein Is Worth A Legion Of PhD Drones

Creativity goes from 0 to 1 and bodies aren't going to solve the problem

Brett: China keeps graduating more bachelor of science and bachelor of engineers than anywhere else in the world. China's universities are pumping out more science graduates than us, but they're not pumping out more innovators.

It's not like the students that are coming out of those universities in China with their science degrees are going off and doing innovative stuff. It's quite the opposite, because they've been trained in a particular way. They're being trained to memorize this textbook, respond to this exam. They can't think outside of the box.

They've been trained that, "This is what's true. This is the unquestioned correct way of thinking about science." That might be good for being able to imitate, as we see, but it's not going to be the thing that enables you to push forward the frontier in technology, let alone fundamental physics or anywhere else.

I don't care what the statistics are on how many science graduates they've got. That makes no difference. Give me 10 innovative, creative, young physics graduates over 50,000 physics graduates who all are able to pass the exam with 100% efficiency any day.

Naval: So, one Einstein is worth the legion of drones with PhDs in physics. It doesn't matter. Creativity goes zero to one. And no amount of throwing bodies at the problem will get you there. That's just the nature of memetic evolution; it's just the nature of creativity.

Don't Rely on Credibility Stamps

The generation-long shift from institutions to individuals will be messy

Naval: There are a lot of institutions in our society today that rely on credibility stamps.

They used to be how you gain credibility in society. If you were a journalist writing for *The New York Times* or *The Washington Post*, then you had the masthead of *The Times* and *The Post*. If you're a professor at Harvard, you have credibility because you're a professor at Harvard.

Of course, those systems got hacked. A lot of social scientists who have no business telling the world what to do are now in there with nonsense political models masquerading as economists or natural scientists. You have people who are activists writing under the mastheads of these formerly great newspapers and burning up the credibility capital that these newspapers have built up over time.

The Internet is exposing them slowly but steadily, and we're going through a transition phase where the masses still believe in the institutions.

We're caught in this [Schelling point](#), this coordination point for the institutions: How do I know if I should hire you? Will you have a diploma from Harvard? I know it's not as good as it used to be. I know a Harvard humanities diploma's probably nonsense at this point, but I don't have any other credibility metric to filter you and I need to do it in an efficient way.

What we're seeing is the transition of power from institutions to individuals, but it's going to be messy and it's going to take at least a generation.

In the meantime, the institutions are fighting back. We're in the *Empire Strikes Back* phase where they're trying to take over the new platforms like Twitter, Facebook, Patreon, which empower the individuals.

Brett: The university and all of the academia have a very big stick in terms of being able to train their own next generation of teachers who then go on to teach the next generation of primary and secondary school students.

Naval: It's a priesthood. You're only allowed to say what the priests have approved, and you can only say that if you are a priest, and the priests get to decide who's a priest.

Innovation Requires Decentralization and a Frontier

Technology has swung us towards centralization in the last decade

Naval: Innovation requires a couple of things. One of the things that it seems to require is decentralization.

I don't think it's a coincidence that the Athenian city-states or the Italian city-states or even the United States—when it was more freeform and less federal government controlled—were hotbeds of innovation, because you had lots and lots of competition. People could switch from one state to another if their ideas weren't welcome, and there was a robust competition of ideas.

The real diversity that matters is the diversity of ideas, not the diversity of skin color.

You also need a frontier. You need something new to explore—either an intellectual frontier or a physical frontier. We've occupied California. If anything, now California is the institution, the establishment. It's no longer the front of the Wild West. Maybe we need one in space. Maybe we need intellectual ones like we have in cryptocurrencies.

It's the nature of the Wild West that they're always filled with scammers; they're always filled with crimes; they're always filled with very strange and odd things, because they tend to attract a weird crowd. But at the same time, it is where a lot of the innovation is going on.

I see a lot of lamenting from old school scientists and entrepreneurs. "Where are the new entrepreneurs welcome?" I think Paul Graham, the Y Combinator founder, a brilliant guy, tweeted something along the lines of, "Steve Jobs... and people like him wouldn't last a day inside the companies they created." He'd be canceled by his own team.

But Steve Jobs today would be in crypto. He'd be in crypto with all the scammers and all the criminals and all the weirdos, but at least there he'd have a space to be weird. He'd have a place to be different. He'd have a place to try new things without having to constantly answer to someone.

There is a pendulum between centralization and decentralization.

For example, if you look at the crypto world, centralized finance ends up very ossified. You have the government and the regulators telling you exactly what you can and can't do. You get regulatory capture, and next thing you know, Wall Street is sucking 20% of the profits out of the economy—and crypto can replace that.

So you get decentralization pressure where people can do it in a freeform, programmatic way. But then you end up with a lot more scams, fraud and losses as well.

An analogy might be that, in olden times, you worried about brigands and robbers in the forest, so you appealed to the king. The king builds a nice keep, the king mints the money. But next thing you know, the king is debasing the currency and the king is throwing people in jail. Then some people run off into the forest and they become brigands again because they want their freedom. But now, of course, they're subject to attacks and harassment from their peers.

So there's a natural pendulum swing that goes on in history between centralization and decentralization, and I think the arc of technology actually swung us towards centralization in the last decade.

I'm a big fan of Amazon, but it's a very centralized entity. I think that there's a decentralization arc that is taking place even in that industry. Things like Shopify are coming up and enabling small stores to compete. Local delivery services like DoorDash are centralized services, but they're allowing a decentralized army of restaurants and local shops to compete against centralized services.

We're going to see this arc go back and forth.

The Poverty of Compromise

Compromises test ideas no one ever thought were correct in the first place

Brett: This idea of questioning things that hitherto you thought were unassailable in a particular domain is really interesting.

For millennia people have wondered about the best way to conceive of what democracy is.

Plato asked, "What is democracy?" and he had the question about who should rule. That's the whole idea of democracy, supposedly. We'd have to figure out who should rule. Should it be the philosopher kings who should rule? Should it be the population of citizens?

Plato decided that the mob would readily vote away the rights of a minority, and that's what he thought democracy was.

But Popper questioned this whole idea of looking at what democracy was. He went even deeper and roughly said, "Democracy has got nothing to do with who should rule. Democracy is the system which allows you to remove policies and rulers most efficiently without violence. And that's how you judge different democratic systems."

So you can actually make a judgment on France, England, the United States, Australia, Canada. Do these places have better or worse kinds of democracy to the extent that we're actually able to get rid of the people that we don't like from the democratic system quickly, efficiently, easily, without violence?

That's the measure of a good democratic system, rather than trying to figure out which is going to give us the best rulers. That's the same mistake as saying, "What method of science is going to give us the true theory?" No method of science is going to give us the true theory.

Science is an error-correcting mechanism. All we can hope for is to get rid of the bad ideas. And by doing that, we've corrected some of our errors, and then we can move forward to find something that's a better theory than what we had before.

This raises the idea of how to make good decisions when you're at loggerheads with someone else.

There's this idea that compromise is supposed to be a virtue of some kind, and it's not. It's preferable to having a violent confrontation if you've got two people who otherwise can't possibly reach an agreement and they're going to get into a battle of some sort.

If you're in a situation where person A has idea X and person B has idea Y, the common understanding of a compromise is that it's somewhere between X and Y: Person A won't get everything they want, and person B won't get everything they want. They come up with a compromise, which is theory Z.

We shouldn't be surprised when theory Z proves not to work, because neither person ever thought it was the best idea in the first place. Person A goes back to saying, "I always told you that X was the correct idea," and person B goes back to saying, "I always told you that idea Y was the best idea."

They haven't made any progress whatsoever. They've shown that Z is wrong, but no one ever thought that Z was correct in the first place.

This is the poverty of compromise, and this is what you get in science at certain times. It's everywhere in politics as well.

Free Markets Provide the Best Feedback

The alternative is feedback from whomever has the most guns

Naval: Marc Andreessen summarizes this nicely as "strong opinions, loosely held"

As a society, if you're truth-seeking, you want to have strong opinions but very loosely held. You want to try them, see if they work, and then error-correct if they don't.

But instead what we get is either strong opinions strongly held—which is the intolerant minority—or we get weak opinions loosely held—which is this compromised model where no one really takes the blame, no one gets credit, no one gets to try the way that they want to, and everybody can then fall back on, "Real communism hasn't been tried." Although, in that case, real communism has been tried; it just hasn't worked out well.

As a digression, one of the common critiques I hear people say is, “We need to move to a post-capitalist world. Capitalism isn’t working.” OK, what is your alternative? Usually this is where people start fumbling because there aren’t a lot of choices.

When you’re trying to figure out how to divvy up credit, divvy up resources and reward people for their work, you have two choices: feedback from free markets and reality—and the best model for that is money—or feedback from people, which is where communism ends up, which is a group of people who decide that you did the best work.

Now, who decides you did the best work? Someone has to be in charge of doing that, and invariably that ends up being the biggest thug.

I don’t think that it’s an accident that every communist country degenerates into a dictatorship. Communism never seems to actually be run by a distributed majority of the people. It always ends up being run by a bunch of people who are taking charge.

It’s just human nature that if I get to decide who gets the gold, it’s going to go to my friends, family and the people that I like. And that’s invariably what ends up happening.

Either you need an objective function to carve it up—and money is the known objective function—or it becomes all subjective. And if it’s subjective, then who’s to say you’re carving it up instead of me? We’re just going to decide based on who has more physical force, who has more guns.

Brett: What we say on the side of free markets is that we’ve extracted coercion out of that decision-making process. No one is forced into purchasing a service or undertaking an agreement.

The only time that force is applied is when the government gets involved. The people at the top then say, “This is the best decision and you will have to agree with it; otherwise, there’s going to be a man with a badge and a gun turning up at your door.”

All that we’re saying when it comes to the free market is that the individual gets to decide without being coerced. Now, I could be wrong, but why shouldn’t they try and make mistakes? It’s the only way to make progress.

The only way to error-correct is to actually try something else.

Making Something Social Destroys the Truth of It

Science’s biggest breakthroughs came from unpopular people

Naval: Making something social destroys the truth of it because social groups need consensus to survive—otherwise they fight and can’t get along—and consensus is all about compromise, not truth-seeking.

Science—at least the natural sciences—was this unique discipline where you could have an individual truth-seeking on behalf of the rest of society. Other individuals verify that they did, indeed, have the best current model of how reality works, and then that could be spread out through inventions to the rest of

society.

But the social sciences are this virus that crept into academia and have taken over. Social sciences are completely corrupted.

First, they need to appeal to society for funding, so they are politically motivated. Then, they themselves are influenced in society because the studies and models are used to drive policy. So, of course, that ends up corrupted as well. Now even the natural sciences are under attack from the social sciences, and they're becoming more and more socialized.

The more groupthink you see involved, the farther from the truth you actually are. You can have an harmonious society while still allowing truth seekers within the society to find truth and to find the means to alter and improve reality for the entire group.

Historically, most of the scientific breakthroughs didn't come from scientific institutions. The big ones came from individual natural philosophers who were very independent thinkers who were reviled in their time, often persecuted, who fought against the rest of society on the basis of their truths. And it took decades or centuries—often after their deaths—before those truths were accepted.

A lot of these academic theories don't actually stand up either to replication—if you look at what's going on in psychology—or even to reality.

[Rory Sutherland](#) has this great quote where he said something along the lines of, "[Marketing is the science of knowing what economists are wrong about](#)." Economists assume perfectly rational behavior, but humans are obviously wetware biological creatures, so you can hack around that using marketing.

Nassim Taleb would go even further and say that they assume false rationality. Humans are pricing in the risk of ruin, the risk of going to zero, and the academics are making mistakes about ergodic reasoning. They're assuming that what's good for the ensemble is good for the individual, and it's not.

An individual doesn't want to go to zero—doesn't want to die—so they will not take risks of ruin and they will not take risks of bankruptcy; whereas a group should be willing to take a risk of bankruptcy because that's spread out among so many different people.

Groups Never Admit Failure

You get a schism instead

Naval: Groups never admit failure. A group would rather keep living in the mythology of "we were repressed" than ever admit failure. Individuals are the only ones who admit failure. Even individuals don't like to admit failure, but eventually, they can be forced to.

A group will never admit they were wrong. A group will never admit, "We made a mistake," because a group that tries to change its mind falls apart. I'm hard pressed to find examples in history of large groups that said, "We thought A, but the answer's actually B."

Usually what happens in that case is a schism, where you go from the Catholic Church to Protestant and so on. There's a divergence and usually a lot of infighting. This happens in crypto land, too, where the coins fork. Bitcoin doesn't suddenly say, "We should have smart contracts." ETH doesn't suddenly say, "We should have been immutable."

I was on the board of a foundation that was charged with giving out money for a cause, and I found it very disillusioning because what I learned was that no matter what the foundation did, they would declare victory. Every project was victorious. Every project was a success. There was a lot of back slapping. There were a lot of high-sounding mission statements and vision statements, a lot of congratulations, a lot of nice dinners—but nothing ever got done.

I realized this was because there was no objective feedback. Because there is no loss—it's all social profit—they couldn't fail. And because they couldn't fail, they misdirected resources all day long. And eventually, of course, such groups run out of money.

If you want to change the world to a better place, the best way to do it is a for-profit because for-profits have to take feedback from reality. Ironically, for-profit entities are more sustainable than non-profit entities. They're self-sustainable. You're not out there with a begging bowl all the time.

Of course, you lose the beautiful non-profit status; you have to pay your taxes; and also you can get corrupted by being purely for-profit. But I would argue that the best businesses are the ones that are for-profit, sustainable and ethical so you can attract the best people. You can sustain it because it's a mission and it's not just about the money—because there are diminishing returns to making money.

There's a diminishing marginal utility to the money in your life.

Knowledge Makes the Existence of Resources Infinite

We're going to keep creating new knowledge and new resources

Brett: Knowledge is the thing that makes the existence of resources infinite. The creation of knowledge is unbounded. We're going to keep on creating more knowledge and, thereby, learning about more and different resources.

There's this wonderful parable of europium in *The Beginning of Infinity* where David talks about when the first color television started to be manufactured about 60 years ago. There was a cathode ray tube type where you'd fire a stream of electrons at a phosphorescent screen. The phosphorescent screen would have these pixels, three different colors, one of which was red, and those red phosphors on the screen were filled with the element europium.

The interesting thing about europium is, when you put electricity through it, when you excite it, it glows with this red color. The extra-interesting thing about europium is that it is the only such element on the periodic table; it's the only chemical that will do that. If you fire electrons at it, it will glow the red that you need to have for color television.

It was calculated that there's only a certain amount of europium on the earth, and that amount of europium was quickly being consumed by cathode ray tube manufacturers. So the scientists had a perfectly robust mathematical theory about how the number of cathode ray tubes was finite; therefore, we're going to run out of cathode ray tubes.

It's true, in a very narrow sense, that for any given resource you're going to have a finite amount on planet Earth. Of course, there's going to be europium in outer space and you could probably mine it there, but the deeper point is that no one has cathode ray tubes anymore. The whole idea of color television has nothing to do with the extraction of europium these days.

We've all got LCD screens, we have plasma screens, and there will probably be something else coming in the future that will have absolutely nothing to do with the kind of technology we have today. But we're still going to have color television or color screens.

This is true for absolutely any resource that we can think of.

You might very well make a perfectly good Malthusian calculation that we can't keep on burning wood if you happen to be living on the African savanna, because eventually all of the forests are going to be burned down. Obviously, we're going to run out of wood. There's a finite amount of wood. Even if you can grow more wood, eventually the consumption of wood is going to outstrip the amount that's there. And this is the argument that's made for coal, oil, and everything else that we happen to be consuming.

Naval: Even so-called empty space has a lot of matter and a lot of things that could be converted into energy. There is no limit to the number of resources out there. There's purely a limit to knowledge.

Unfortunately, there's a pessimistic assumption here that people make that human creativity is bounded, and I think it's the people who have not built things, who have not created new things from scratch, who seem to feel this the most.

To a Caveman Very Few Things Are Resources

There was a time when coal wasn't a resource

Brett: There was a story on ITV in the U.K. talking about how much supposed waste Amazon produces, that Amazon was routinely destroying a whole bunch of products.

I thought, "Why are these people inserting their opinion into a business that they know absolutely nothing about?" Would they prefer Amazon to have the perfect knowledge of precisely how many products need to be made? In other words, an epistemologically impossible situation to be in. Or would they prefer that Amazon made insufficient products, so the people who wanted to purchase them weren't actually able to get ahold of them?

What Amazon does, of course, is make slightly more than what they need. That's what happens in any business. They make slightly more than what they need now and again.

Naval: I once had a venture capitalist argue to me that there were too many kinds of shoes and it was an example of how capitalism had failed because nobody needs this many kinds of sneakers.

My question to him was, “When did you know that there were too many shoes?” What’s the point in history where we decide there are too many shoes? Before we needed more shoes because we needed more stretchy shoes, we needed more durable shoes, we needed thicker soled shoes, we needed lighter shoes, we needed all kinds of amazing shoe innovations.

And then at some point, somebody decides, “Actually we have enough shoes. Now we need to kill all the other shoe lines.” Where did you come up with this idea that you just happened to be born at the right time and the right place to identify that yes we have enough shoes?

This is a certain parochialism that everyone falls into.

There’s a more macro version of it, which is this “we’re running out of resources” philosophy. It starts with this idea that the Earth is finite, that there’s this finite set of resources and we’re consuming them all. And therefore we’re all going to die if we don’t tamp back our consumption.

First of all, how did you decide that it was the Earth? How did you decide that your town wasn’t running out of resources? Why wasn’t the town the actual area that you wanted to save and then everything outside of that was foreign and unreachable?

Why draw the boundary around the Earth? We could go to the solar system. We could go to the galaxy, we could go to the universe. We could go to the multiverse. There are a lot of resources out there if you know how to harness them.

Then, how do you define what a resource is? A resource is just something that through knowledge you can convert from one thing to another.

There was a time when coal wasn’t a resource; iron wasn’t a resource. To a caveman very few things are resources—just a few edible plants and a few edible animals and that’s it.

Domestication, harvesting crops, metallurgy, chemistry, physics, developing engines and rockets—all of these are things that are taking things that we thought were worthless and turning them into resources. Uranium has gone from being completely worthless to being an incredible resource.

This finite resource model of the world implicitly assumes finite knowledge. It says knowledge creation has come to an end. We are stuck at this current point, and, therefore, based on the knowledge that we have currently, these are all the resources available to us. Now we must start conserving.

But knowledge is a thing that we can always create more of.