My First Principle Approach to Science and Technology

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Some years ago I sat down to write my personal essay for MIT, and somewhere in it I wrote that I was obsessed with learning how and why things work the way they do.

It was true. It was also, I'm fairly sure, one of the most common sentences in the pile. Everyone who has ever taken something apart, or stared at an equation for too long, has written some version of it. I wrote mine and moved on to the next paragraph.

What I didn't write was *why*. Why am I obsessed with this? What does it do for anyone other than me? I left it out because I didn't have an answer, and I knew I didn't. I had been calling it passion, which is the word people use when they would rather not look too closely at the thing. This article is me looking closely.

The one thing we all agree on

Here is what I believe, and I'll say it plainly, because hedging it would be a lie. Every career path and every serious human effort should, in some way, push forward humanity as a whole. Not one company or one country. All of us, every civilization.

I don't say that because I'm sure of some grand purpose. I'm not. Nobody has shown me, beyond all reasonable doubt, how or why we are here, and I'm suspicious of anyone who claims they have. But there is one thing that every human shares, whatever they believe about the rest: we want to move forward, and we would rather do it together than alone. That is a thin foundation. It's also the only one I've found that doesn't collapse when I push on it.

So my obsession couldn't be a hobby. If it was only curiosity for my own entertainment, then it was selfish, and I wasn't willing to build my life on that. It had to connect to this somehow. It took me an embarrassingly long time to see how.

The objection I take seriously

The way I got there started with an objection. Look at the computer. Brilliant people have built layer on top of layer on top of layer so that you and I never have to think about what a computer actually is. You tap a piece of glass and a message crosses the planet. Someone already did the hard thinking, packaged it, and made it efficient. So why would anyone want to tear all of that away and go stare at the bare machine? It sounds like a waste of time. It sounds like grinding your own flour in a world full of bakeries.

Music is the same argument. Music has advanced absurdly far. Why would I want to strip off the beauty, the part that actually makes you feel something, and go examine the skeleton underneath: how sound moves, how patterns and melodies are really built? It almost feels rude. Like taking a song apart to find out why it made you cry.

And then the classical forces, the ones that govern the whole universe. We've built bridges and engines and satellites. We have equations that work. Why keep digging at things that are supposedly solved?

These are reasonable questions, and I'm not going to pretend otherwise. At the time of that essay I didn't have a good answer to any of them. I do now.

Everything is a tree

Everything is a tree.

I mean that almost literally. Think of any human achievement as a node, a point where something genuinely new entered the world. The invention of the computer is a node. Now look at what grew out of it: monitors, keyboards, operating systems, networks, the internet, the phone in your pocket, most of the modern world. Those are branches. Every one of them ended in nodes of its own, and those nodes grew branches, and those branched again.

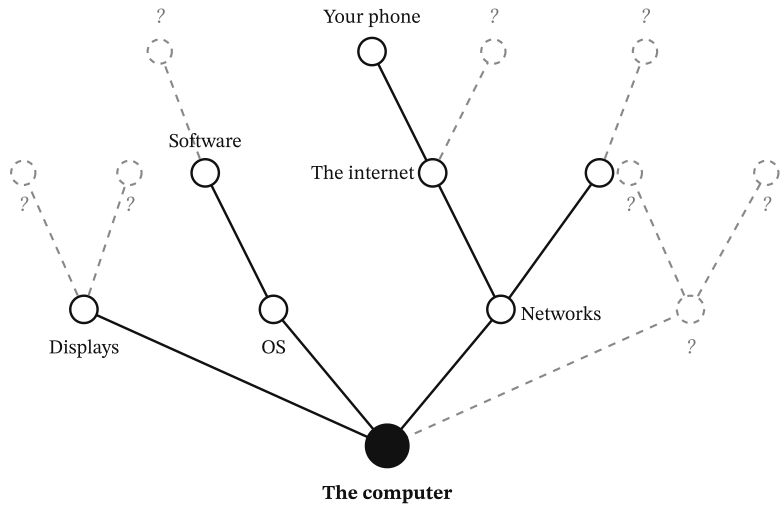


Figure 1. One node and a few of the branches that grew from it. Solid lines are branches we have grown. Dashed lines are branches that could exist and haven't been grown yet. The labels are simplified on purpose.

We are living inside that tree. Not at the trunk. We are way out on the thinnest twigs, so far from where it started that most of us never think about there being a trunk at all. We call the leaves "technology" and use them every day without asking what they're attached to.

Here is the part I actually believe, and I want to be honest that it is a belief and not a proof: every node has infinitely many possible branches. Not a lot. Infinite. What we have is only the handful that were obvious at the time, or profitable, or lucky. Around every node there is a huge unexplored space of things that could have grown and didn't, because nobody went back and looked.

And the more branches we grow, the more advanced we become. That's it. That's how I define advancement: more branches.

Once you see it like this, the objections fall apart. Stripping away the layers isn't a waste of time and it isn't nostalgia. It is walking back down the tree to the node itself, to the thing as it was before

anyone built on top of it, and asking what else could have come out of here. The people who built the first computers couldn't have described a smartphone, let alone the internet. They weren't trying to. They built a node, and the branches came after. I believe the computer has far more applications and benefits than we have found so far, way beyond what we're currently using, and I don't think we find them by polishing the leaves. You go back to the node. You learn how it works, really works, down to the part where it stops being convenient.

Same with music. When you understand how sound and pattern behave, you don't lose the beauty. You gain the ability to grow branches nobody has heard yet. Same with the forces of nature. The layers tell you what to do with a thing. First principles tell you what the thing could become.

That's why I'm obsessed. It was never really about me understanding things. It's about handing the people after us more branches than we were handed.

Does going back to the node actually pay off? A little math

Quick note before the numbers. I'm not adding math here to look smart or to make this sound more serious than it is. I honestly didn't want any math in this article at all. But I tried to explain the next two ideas without it and they came out vague and hand-wavy, so I gave in. I'll tell you which numbers are real and which ones I made up to show a shape.

A real one: GPS

GPS is a branch that grew from a node people studied for reasons that had nothing to do with maps. Satellite clocks run differently from clocks on the ground, for two reasons that come straight out of relativity. They're moving fast, which slows them down by about 7 microseconds a day. And they sit higher up in Earth's gravity, which speeds them up by about 45 microseconds a day. Net result: they gain roughly 38 microseconds every day.

Thirty-eight microseconds sounds like nothing. But GPS works by timing radio signals, and radio travels at the speed of light, about 3×10^8 metres per second. So:

$$38 \times 10^{-6}\ \text{s} \times 3 \times 10^{8}\ \text{m/s} \approx 11{,}400\ \text{m}$$

That's about 11 kilometres of error, piling up *every single day* if nobody corrected for it. Your phone would put you in the wrong part of the city by lunchtime. It works because somebody understood time and gravity at the very bottom, and somebody else turned that into a branch that now sits in your pocket. That's everything I've been arguing, in one number, and honestly it's the number that finally shut the "waste of time" objection up for me.

A made-up one: why I can't have it all

This next one is the shape of my frustration, with invented numbers. Say every node leads to 3 branches. Then the number of nodes explodes with each level of depth d:

$$\mathrm{N(d)} = (3^{\mathrm{d}+1} - 1) \,/\, 2$$

Table 1. Total nodes in a tree where every node has 3 branches. The 3 is made up. The shape is real.

Depth d	Total nodes N(d)
1	4
3	40
5	364
10	88,573

Now say it takes me about 5 years to really understand one node, down to where I'd be comfortable saying I know it from first principles. That's also made up, and probably optimistic. Give me 50 years of serious work and that's 10 nodes. Ten out of 88,573:

$$10 \,/\, 88{,}573 \approx 0.011\%, \text{ or about 1 in } 8{,}900$$

That's the number I'm up against.

What pisses me off

Now for the part that genuinely frustrates me, and you've already seen the math behind it.

I'm not interested in one node. I'm interested in all of them, at the same time: computation, physics, sound, philosophy, whatever I happen to be staring at this week. Every one of them deserves the full walk back down, and a single node done properly takes years. I can count. I don't have enough lifetime to do it for all of them, and I hate that. It feels like standing in a library the night before it burns down and being allowed to read one shelf.

I've tried to be reasonable about it. Pick one. Specialise. That's what everyone says, and I understand why. But every time I pick, I can feel the others pulling, and I know that somewhere in the branch I'm ignoring is something that matters.

The question I can't put down

So here is the thought I can't shake.

What if I don't have to? What if these nodes aren't separate at all? What if everything we know, everything we've built, every branch and every node, stems from a single node? A trunk underneath all the other trunks. If there is one, then I don't need to walk back to a thousand places. I need to find the one place.

Go back and look at Table 1, because there's something hopeful in it that I only noticed after I wrote it down. The number of nodes explodes, but the depth barely moves. Ten steps from the root, there are almost ninety thousand nodes. Breadth is expensive. Depth is cheap. If a root exists, every one of those nodes is only ten steps away from it, and understanding the root would be worth more than understanding ten thousand leaves. (Real knowledge doesn't branch in perfectly even threes, obviously. I'm only saying the shape suggests where to dig.)

I don't know if it exists. I don't know what it would look like. I'm not going to bullshit you with a conclusion, because I don't have one, and anyone who claims to have one about something like

this should make you nervous.

What I do have is where I'm digging right now. I keep circling the nodes closest to me: computation, and now intelligence. That is why I'm so stuck on edge AI and AI efficiency. It feels like the same question asked again. Strip everything away and ask how little it actually takes.

I also have a suspicion, and I'm marking it clearly as speculation, that our fear of AI ties back to that first node. I can't argue it yet. I'll go into it once I'm satisfied with how well I understand edge AI, AI efficiency and inference, and not before. I don't want to say something big and have it be hollow.

If the root exists, I'd rather find it by walking down than by guessing.

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