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SUMMARY

Quantum computing is a complex field that challenges traditional binary computing by utilizing the principles of quantum mechanics. It allows for calculations on multiple outcomes simultaneously through quantum superposition, vastly increasing computational power for specific problems.

- *Quantum mechanics was significantly discussed by leading physicists like Einstein and Heisenberg at the 1927 Solvay Conference.*
- *Traditional computing operates on a binary system (ones and zeros), while quantum computing uses quantum bits (qubits) that can represent multiple states at once.*
- *A qubit can exist in a superposition of states, allowing quantum computers to explore many possible outcomes simultaneously.*
- *The complexity of certain problems increases exponentially with small changes, making them infeasible for classical computers but manageable for quantum computers.*
- *Quantum computing has the potential to revolutionize fields such as cryptography, drug discovery, and material design by solving complex problems much faster than current supercomputers.*

- What the hell is quantum computing? Now, I'm asking this having talked to you about this a lot and still not knowing. - And we're gonna film this one. - I don't consider myself to be a stupid person, but quantum scrambles my brain, so talk to me like I'm a child. You can use your book. - I can use my book. So we have "Quantum Computing for Babies" for you. All right, so John, so this is a ball.

No, I'm just kidding. So, let's talk about this. This is the part of why we wrote this book is that quantum computing's very complex. Niels Bohr, Richard Feynman, they have all- - Who are they? - They are very famous physicists. And they've all said things like, "If you think you know quantum mechanics, "then you don't know quantum mechanics," right? This is a general thing. So don't feel bad that you're like, "I still don't get it." There are people who've been working in 20 and 30 years and there's aspects they have no idea.

But basically in 1927 at the fifth Solvay Conference, Einstein and Heisenberg and Schrodinger and all the physicists you've heard about in pop culture got together and this is really where kind of the idea of quantum mechanics was really discussed by the the Illuminati

of physics, if you will. And that created arguments,
Einstein's famous statements about spooky action at a distance where you didn't believe
two particles could be faster than the speed of light and the way that they communicate
if they were entangled.

All of these debates. And so, great. Fast forward to 1980, Feynman
and Benioff write a paper about the computer as a physical system and basically argued
that they're not digital. If you look down in the transistor, you'll see the little gate
holding the electrons, right? Like, it's a physical thing. - [John] Right. - And because it's a
physical thing, you could use some part of a spin of
an electron or something to calculate on. So the way I like to explain it, which I think, I brought this for you 'cause I know I've tried.

- Yes yes. - This is gonna be the time
you get it, I'm convinced. Is, if you take a coin and you put it flat on
this table in front of us, heads up, it's a one, you
flip it over, it's a zero. Everything from your iPhone
to the iPad, the cameras, super computers, that's how they all work. - [John] Binary. - It's a binary system. Take the same coin and flip it in the air. And when it's at the apex of that spin, is it a one or is it a zero?

And the answer is, it's
in a quantum superposition of every potential probability,
depending who you talk to across every potential
universe, known or unknown, of a one or a zero. And until like a coin toss,
we stop it and measure it, 'cause the act of measurements causes quantum systems collapse, then it comes out as that we still get a one or a zero as an answer. However, in that state we can explore mass amounts of information.

So, let's say that you and I
wanted to travel to 14 states. - So I want before you
jump to the application. - [Whurley] Sure. - Okay, so computing,
traditional computing is binary, ones and zeros. - [Whurley] Absolutely. - And every conceivable
number and every fraction can be represented through binary. So when we think of 32
bits, 64 bit, 512 bit, we're talking about binary. - So, hang on. So, let's roll with that. Let's say we have a four bit system.

It has 16 potential outcomes, right? - Each bit is the one or zero, right? - Right, and we have
16 potential outcomes. We can only be in any one of
those outcomes at one time. Okay, and if we add a
fifth bit, now we have 25 and we can still only be in one of those. If we have four cube bits,
we can be in all 16 outcomes at the same time when

we're doing our calculation and if we add a cube bit, we have two to the N the
number of bits in the system, so it grows exponentially.

The example that I think would help you. - Yeah. - Is we are gonna go film
a TV show together someday. We joke about it all the time. At some point, we're gonna do a TV show. So let's say we want to
take this crew to 14 cities. I could write something on our Macs that in about three to
5,000 seconds would give us the most optimized plan, okay? - Where to travel, the shortest distance. - Where we go, how we go, when we go, wherever we're factoring for.

We only wanna stay at these hotels and want this kind of food,
all of the different variables. We could take it and that's
about what it would take. If we decided, you know what, this is gonna be really popular, let's do 22 cities,
difference of only eight. That same laptop would
take thousands of years to get to what's called the
evaluation time for that answer. And if we went to 28 cities, it would take longer than the
time of the known universe.

This is an example I got
from Michelle Simmons, who's doing wonderful work
with silicon quantum computing down in Australia. And I think it's a really good
example for you to understand because that puzzled look
you have on your face tells me that you now
actually understand it, which is, wait, why is that the case? Why is 22 and 14 so different? And the reason is that there are problems that grow in their complexity, NP and B plus hard and be complete, all the things I just said that
nobody will Google or know.

- Yeah, and you might have
been saying gobbledygook. - Right, right, right, exactly. That are these class of problems where you just add one little change, just one thing and all of a sudden that's not something we do
even on a super computer. So take breaking encryption,
take finding new drugs, better battery designs, material designs. These are things that
supercomputers spend years trying to model and simulate and do stuff that a quantum computer will do potentially in seconds,
minutes, hours, days.

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