

Life 3.0

Being Human in the Age of Artificial Intelligence

by Max Tegmark

Reviewed by Sophie Dulesh

Life 3.0 pursues two different topics, each of which easily constitutes a grand undertaking in itself. The first topic (A) is the fast-approaching new era of artificial intelligence (AI) with all the benefits and threats it may bring to humanity. The second topic (B) is the eternal human quest to understand the universe, its origin and laws, whether life evolved or was created by design, and the use of mathematics to explore these questions. The latter topic follows naturally from the ideas of Tegmark's earlier book *Our Mathematical Universe* (Random House, 2014).

Both books captivate with their passion for grand ideas, both are informative, thought-provoking, and (last but not least) easily accessible to the mathematically untrained majority ("equation-illiterate" like myself). Perhaps, therefore, my review may somewhat reflect the views of readers who constitute the equation-illiterate majority.

(A) Tegmark on Artificial Intelligence

AI and bioengineering are two new superforces that will define our future. Tegmark sounds the alarm: we are not ready for their arrival! The danger stems mostly from our unpreparedness to finely align AI goals with our own,

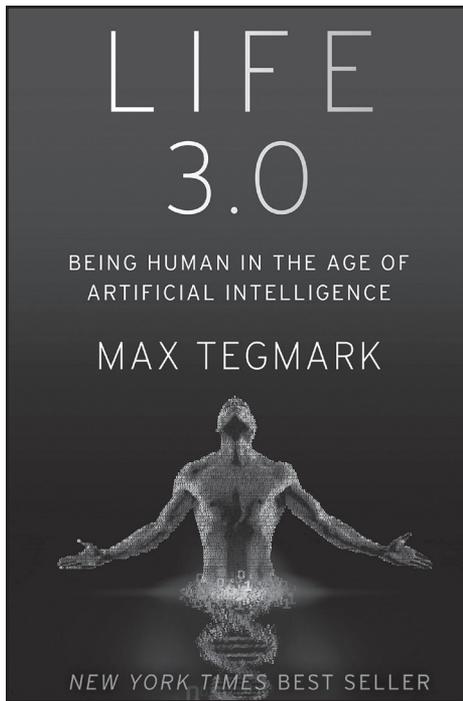
and from the under-intelligence of some forms of AI, which may have some potentially cosmic rather than local or even global consequences:

We need to build AI with verification, validation, security and control. Our laws need rapid updating to keep up with AI. AI may increasingly replace us on the job market. This need not be a bad thing as long as society redistributes a fraction of the AI-generated wealth to fight inequality.

Tegmark's wake-up call is anything but premature.

Tegmark sees a three-level history of life on Earth: Life 1.0 consisted mostly of bacteria capable of little more than replication and survival. Life 2.0 saw the animals (including humans) with some ability to manipulate their environment.

[Only] life 3.0 can learn during lifetime and pass it to the next generations; that is it can modify its own genes... Life 1 (biological stage) is life where both the hardware and software are evolved [Darwinian evolution] rather than created. Life 2 (cultural stage) is life whose hardware is evolved, but whose software (the algorithms and knowledge that you use to process the information from your senses and decide what to do) is largely designed.



LIFE 3.0:
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Life 3 (technological stage) designs its software and hardware... hence it is the master of its own destiny finally fully free from its evolutionary shackles. ...Most matter on Earth that exhibits goal-oriented properties may soon be designed rather than evolved... (My underlining)

Tegmark offers also some fascinating futur-ology dreams:

Laser-sail rockets could let humans make the four-light-year journey to the alpha-Centauri solar system in merely forty years... All the necessary information about humans can be transmitted at the speed of light, after which the AI can assemble quarks and electrons into the desired humans..."

Or:

A wormhole is a shortcut through spacetime that lets you travel from A to B without going through the intervening space...

(B) Tegmark on humanity's quest to understand the universe

Tegmark presents readers holding traditional attitudes with a formidable challenge:

...a crazy-sounding belief of mine [is] that our physical world not only is described by mathematics but is mathematics, making us self-aware parts of a giant math object... Our physical reality is entirely mathematical (information-based...), as I explored in my book *Our Mathematical Universe*... (My underlining)

This perspective, which may seem counterintuitive, even unacceptable, is called mathematical Platonism.

But quantum science since its inception has been known for its unorthodox counterintuitive concepts. It deals with the objects too large or too small for ordinary human experience, so far removed from it in fact that we (and not just us ordinary mortals but even the top echelon of physicists themselves) find some concepts hard even to mentally visualize. Think, for example, of "superposition," defined by Tegmark in *Our Mathematical Universe* as a "quantum-mechanical situation where something is in more than one state at once... a radioactive atom in superposition of being decayed and non-decayed... at the same time."

Yet, in the near-century of its existence, quantum science has proven not only to be scientifically testable and falsifiable, but also invaluable in its unique predictive power. Human

intuition, so useful in pre-quantum science, does not work at the quantum level; but equation-literacy does and appears to be singularly efficient and invincible. Still, it is supposed to remain rational and evidence-, not belief-based.

As he explains in *Our Mathematical Universe*, Tegmark believes that

...our reality is a mathematical structure [set of abstract entities with relations between them], making us self-aware parts of a giant mathematical object... Mathematical structures are eternal and unchanging: they do not exist in space and time – rather, space and time exist in (some of) them.

And more, from *Life 3.0*:

Out of all ways that nature could choose to do something, it prefers the optimal way, which typically boils down to minimizing or maximizing some quantity. There are two mathematically equivalent ways of describing each physical law: either as the past causing the future, or as nature optimizing something... I feel that [the second] is more elegant and profound. So, if nature itself is trying to optimize something, then no wonder that goal-oriented behaviour can emerge: it was hardwired in from the start, in the very laws of physics... The goal-oriented behaviour appears to endow particles with the goal of arranging themselves so as to extract energy from their environment as efficiently as possible... [My underlining]

These particles are purely mathematical objects in the sense that their only intrinsic properties are mathematical properties – numbers named charge, spin and lepton number. They do not obey the classical laws of physics: mathematically their state... [can] be described by a wavefunction, describing the extent to which they are in different places: they can both be here or there and in several places at once in a so-called superposition...

Most matter on Earth that exhibits goal-oriented properties may soon be designed rather than evolved. Our Universe keeps getting more teleological... Matter seemingly intent on maximizing its dissipation; primitive life – on replication. Humans

– on pleasure, curiosity, compassion; machines built to help humans pursue their human goals.

“Describing each physical law... as the past causing the future...” is, of course, our classical Cartesian way that explains irreversibility of time through unassailable causality (a future event cannot occur before the past one that was its cause); it has faithfully served Western natural philosophy as the only proven scientific method since Galileo. Quantum science, however, operates outside our familiar four-dimensional spacetime with its evidence-based causality. To “feel that [one way of describing a phenomenon rather than another way] is more elegant and profound,” is our classical intuitive approach, which is inapplicable in quantum science.

Can matter itself optimize anything, and behave in a goal-oriented way? Tegmark’s response: “Nature appears to have a built-in goal of producing self-organizing systems that are increasingly complex and life-like, and this goal is hardwired into the very laws of physics.”

“Appears” through what and to whom? Through equation-literacy to at least some of the literati. The majority, however, including many equation-literate physicists, may choose not to jump to conclusions. The problem, for now at least, is that there seems to be no way to investigate further, either through observation or by experimentation. At present, higher mathematics appears to offer the only path and (in contrast to our common intuition) it allows for this “crazy-sounding belief,” for reasons that nobody knows. Might AI come to our assistance?

Tegmark’s *Life 3.0* is a timely engaging book that serves a critically important social goal: to focus our attention on the Artificial Intelligence that is here to stay and will define our future. •

Russian-born **Sophie Dulesh** obtained her medical degree in that country and worked for 27 years as a general practitioner and medical researcher before immigrating to Canada with her family in 1980, where she worked as an MD for another 23 years. Sophie is interested in philosophy and the history of religion. She is the author of two books (in Russian) and many articles on medical research, as well as of non-fiction books, including *The Trouble with Religion*, and short stories.