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The Evolution of Metaphors: How Each Era's Technology Shaped Its Worldview

Introduction

Throughout history, philosophers and scientists have often explained the cosmos and life by drawing on the cutting-edge technologies and crafts of their era. Each new paradigm – from the potter's clay to the steam engine to the computer – has provided a fresh metaphor for "how the world really is," usually accompanied by claims that earlier explanations were naive or misguided. This report presents a comprehensive historical survey of how worldview-shaping metaphors have evolved in tandem with technology, from ancient mythic imagery to the mechanistic clockwork of the Scientific Revolution, onward to the information-based and computational analogies of the 20th century. By tracing this progression, we can discern a pattern: as our tools and scientific insights change, so do the dominant allegories used to make sense of reality. Finally, we consider the emerging age of artificial intelligence (AI) – large language models and quantum computation – and predict how these new technologies might spawn yet another shift in ontological metaphors. The goal is to elucidate how each era "leaned into" its latest innovations to communicate complex ideas to the public, often with far-reaching effects on philosophy, science, and society.

A Warning of Cycles: Understanding this historical pattern also serves as a warning. In each age, proponents of the new worldview often dismissed prior concepts (sometimes unfairly) as primitive. The four ancient elements were declared obsolete by mechanistic science; vital spirits gave way to clockwork causality; later, the "cosmic machine" itself was reframed as information or computation. If history is a guide, the current fascination with AI and digital technology may likewise tempt us to proclaim a revolutionary new truth of existence – for example, that *"the universe is a neural network"* or *"reality is a simulation"*. While such ideas can be insightful, they are likely, at least in part, metaphors shaped by contemporary tools and surprises (just as previous eras' ideas were). Recognizing the lineage of these metaphors can temper our hubris and remind us that each paradigm, however powerful, may eventually be supplanted or integrated into a broader understanding.

In the sections that follow, we delve deeply into key historical epochs and their prevailing metaphors. We examine how ancient peoples, lacking machines, conceived of life as animated by breath and the cosmos as woven or sung into existence. We then trace the rise of mechanistic thought when clockworks and engines inspired thinkers to imagine nature as a grand mechanism of parts and laws. Next comes the information age, which ushered in views of the world as composed of data, code, and computation – extending even to the notion that **"it from bit"** (matter from information) underlies physics [1]. Finally, we discuss the nascent AI era, exploring how **language models and quantum ideas** might fuel new analogies (e.g. the mind as a quantum computer [2] or the universe as a self-learning algorithm [3]). Each section provides concrete examples, with extensive citations, to illustrate how the **"technology of the day"** became entwined with ontology and cosmology. Let us begin at the very origins of human thought, long before engines or computers, when the fundamental forces of nature were explained through the lens of breath, clay, song and craft.

Ancient Worldviews: Breath, Clay, Weaving, and Music

In humanity's earliest philosophies and mythologies – long before mechanical inventions – the prevailing metaphors for life and the cosmos were drawn from **organic phenomena and artisan crafts**. Without clocks or engines to provide models, ancient thinkers leaned on what they knew: the vital breath that animates living beings, the clay and wood shaped by human hands, the interlaced threads of textiles, and the harmonious sounds of music. These metaphors were not mere poetic flourishes; they were often presented as literal accounts of creation and reality. Let us explore a few dominant ancient motifs and their technological (or natural) roots:

- **Breath as Life-Force (Animism and Vital Breath):** Across many early cultures, the act of breathing was equated with the presence of life or spirit. It's no coincidence that in numerous languages the word for "spirit" or "soul" originally meant *breath* or *wind*. For example, the ancient Greek term *pneuma* (πνεῦμα) means "breath" and by extension "spirit," and Greek physicians and philosophers believed the *pneuma* was the animating force in living creatures [4]. Similarly, Latin *spiritus* meant "breath" before it meant "spirit" [5], and the Hebrew *ruach* (רוּחַ) likewise means "wind/breath" and "spirit." In Sanskrit, *prāṇa* denotes the life-breath or vital energy. These linguistic echoes show a common ancient intuition: *living things move and think because an invisible breath-like essence inhabits them*. Breathing distinguishes the living from the dead; thus, breath was a concrete phenomenon that became a metaphor for the intangible soul. In ancient creation narratives, this idea appears vividly. The Hebrew **Book of Genesis** describes God forming the first man from dust and "breathing into his nostrils the breath of life" to make Adam a living soul [6]. In Mesopotamian myth, the goddess Aruru pinches off clay to create Enkidu and "brings him to life" (paralleling the breath motif) [7]. This notion of **divine or cosmic breath animating inert matter** can be seen as a *proto-technology metaphor*: the act of blowing air (a very immediate human ability) is imagined to impart life, much as a bellows can stoke a fire. The concept of *anima mundi* (world-soul) in later Stoicism also held that a cosmic breath or spirit pervades and moves the entire universe [8]. In short, **air and breath were the "technology" of vitality** for ancient people – a mysterious, invisible power that nevertheless was felt in every inhalation and gust of wind.

- **Clay and Craft: The Cosmos as a Shaped Artifact:** Early civilizations were profoundly shaped by craft technologies like pottery, weaving, metalworking, and carpentry. It is thus unsurprising that creation myths often depicted gods as artisans. A widespread motif is the **creation of humans from clay or earth**, as a master potter would fashion a vessel. In the ancient Near East, humans were said to be molded out of mud or clay by the gods and then brought to life – a story found in Mesopotamia, Egypt, and later adopted in the Biblical tradition [7]. For example, Egyptian mythology reveres the ram-headed god Khnum as a divine potter who forms humans on his clay wheel, and then the goddess Isis adds the spark of life [7]. The imagery is concrete and technological: humanity is literally a **manufactured artifact**, shaped from raw earth. The **material (clay)** represents the unformed, and **divine craftsmanship** provides form [9]. As one scholarly summary puts it, "The clay represents an unformed, chaotic material which is shaped and given form by the gods in a creative process" [9]. This potter analogy made the act of creation comprehensible to ancient audiences – it drew on the familiar sight of craftsmen molding clay figurines. In the **Book of Isaiah**, we even find the explicit metaphor "O Lord, you are our Father. We are the clay, and you are our potter; we are all the work of your hand" (Isaiah 64:8), emphasizing divine sovereignty and human humility in material terms [7]. Such metaphors persisted: early Church fathers like St. Basil also interpreted Adam's clay creation as a lesson in human lowliness [10]. Beyond clay, other crafts

were used to describe cosmic origins: **woodworking** appears in the idea of a cosmic carpenter or architect (e.g. the demiurge in Plato's *Timaeus* is a craftsman who geometrically orders the cosmos). Even in the **Middle Ages**, images of God as a master builder or geometer were popular – such as illustrations of God holding a compass to lay out the world's design. These portrayals underscore that, without advanced machines, people saw **artisanal technology as the highest paradigm** and thus imagined the universe as a kind of artifact made with skill and intention.

- **Weaving the World: Fabric Metaphors for Interconnectedness:** Weaving and textile-making are among humanity's oldest technologies, and they furnished another rich source of analogies. Many ancient cultures likened the structure of reality to a **woven fabric or web** – a tapestry in which every strand is interlinked. For instance, Egyptian texts spoke of magic (the divine creative force *heka*) as something "woven" or "knitted" into the universe [11]. Isis and Nephthys, in myth, weave protective spells around the dead, literally "knitting" reality to bring about rebirth [12]. In Greek mythology, the three Fates (Moirai) spin and weave the destinies of both gods and mortals, implying that life events are threads in a pre-ordained textile. Likewise, in Norse myth the Norns weave the fates of beings at the root of Yggdrasil's tree. We even see weaving metaphors in **philosophy** and **poetry**: the 15th-century Indian mystic Kabir, himself born to a weaver caste, described the divine truth through weaving allegories [13]. Why weaving? As a technology, weaving produces a *unified whole out of many distinct threads* – a powerful symbol for a cosmos where everything is connected. Ancient thinkers intuited a kind of network or web underlying reality, long before modern chaos theory or network science. In modern parlance, we still refer to the "fabric of the universe," a phrase that directly evokes textile imagery (even a science commentator noted the uncanny parallel between space-time and cloth in reader comments [14]). The persistence of fabric metaphors suggests they resonate with a fundamental insight: **just as a tug on one thread of cloth can make distant threads tremble, events in one part of nature can reverberate far away** [15]. This is essentially an early way to conceive of what we now call *interdependence* or *nonlocal connections*. Indeed, some contemporary spiritual writers explicitly connect the ancients' woven-universe metaphor to modern ideas – e.g., comparing it to the "butterfly effect" in chaos theory (a butterfly's wing flap influences a tornado) [15]. In short, weaving gave ancient minds a tangible model for an integrated cosmos: reality as a **Great Web** with divine weavers (or all of us as co-weavers) crafting the ongoing pattern [16] [17].

- **The Music of the Spheres: Cosmic Harmony and Frequency:** Another potent ancient metaphor came from the realm of music. Music, especially the mathematical relationships of musical harmony, was a sophisticated "technology" in antiquity (the Greeks studied lyres and pipes to derive numeric ratios for pleasing sounds). The **Pythagorean philosophers (6th century BCE)** extended musical principles to the entire cosmos in the concept of *musica universalis*, the "music of the spheres." They proposed that the Sun, Moon, and planets produce a kind of music through the proportionate speeds of their orbits – not audible music, but an elegant harmonic ordering of nature [18] [19]. Pythagoras discovered that simple numerical ratios (like 2:1 or 3:2) produce harmonious musical intervals on a lyre, and he boldly asserted that celestial motions likewise correspond to such ratios [20]. This implied the universe itself is built on **mathematical harmony** – number and music were the twin keys to reality. Plato later described astronomy and music as sister sciences, both requiring understanding of numeric proportions [21]. Even as late as the Renaissance, scholars like Johannes Kepler clung to the musical cosmos idea; Kepler in 1619 wrote *Harmonices Mundi* ("Harmony of the World") demonstrating how planetary motions could be mapped to musical intervals [18] [22]. The **universe-as-music** metaphor also resonates with ancient ideas in other cultures: in India, the concept of **Nada Brahma** ("Sound is God/Brahman") and the primacy of the sacred syllable *Om*

suggest the world originates from sound or vibration. The Vedic scriptures describe *Om* as the primordial sound from which creation unfolded – "the original vibration of the universe," as later Hindu philosophy puts it [23]. Likewise, some mystical strands of Islam consider the *Word* or divine speech ("Kun" – 'Be') as creative, and Christian theology begins with "In the beginning was the Word (Logos)" – which can be interpreted as a principle of rational order akin to a cosmic language. All these are variations on a theme: **frequency, sound, or word as the substrate of reality**. In modern times, people sometimes echo this in pseudoscientific slogans ("the universe is frequency" or references to vibration); what's notable is that this idea *long predates* modern physics. It arose naturally when music was among the most mathematically advanced sciences available. The idea that *nature has a rhythm or harmony* was deeply appealing and, crucially, it offered a **causal explanation**: things happened because of the harmonies or disharmonies in the "music" underlying reality. While Aristotle himself did not accept literal celestial music (he skeptically noted that if huge planets made noise we'd be deafened, or perhaps we are born hearing it constantly and thus don't notice it [24]), the success of the metaphor is evidenced by its longevity into Kepler's work and beyond. Thus, ancient and medieval cosmology had a strong **acoustic and musical component** – an early foreshadowing of seeing the universe in terms of waveforms and frequencies.

In summary, ancient worldviews were dominated by organic and craft metaphors: life was a breath from the gods, matter was molded clay, fate was a woven cloth, and the cosmos was a grand musical instrument. These analogies used the "high-tech" of their day – which in a pre-industrial context meant **the technologies of the body and simple crafts**. Notably absent is any notion of *impersonal mechanism*. Ancient thinkers did not conceive of nature as an *unconscious machine* but as *ensouled, artful, or organism-like*. This is in line with the fact that complex machinery (gears, engines) were not part of daily life. The world, to them, seemed more like an **organism or a work of art** than like a factory. However, as technology progressed, especially with the rise of complex mechanical devices in the late medieval period, this perception began to shift. We next examine how the transition from an enchanted, artisanal cosmos to a mechanistic one took place.

The Medieval and Renaissance Transition: From Organismic to Mechanistic Views

While ancient and medieval scholars shared many assumptions (such as the geocentric cosmos of Aristotelian physics and a finite universe with Earth at the center), the seeds of a **mechanistic worldview** were planted in late medieval Europe and blossomed in the Renaissance. This period saw the invention or spread of mechanical gadgets like clocks, pumps, and automata, which gradually provided new metaphors for understanding nature. It's important to note that the transition was gradual and did not immediately discard the older metaphors – rather, there was a period of overlap where mechanical analogies coexisted with organic and spiritual ones. Here we discuss this pivotal shift, roughly 1300–1600 CE, highlighting key developments:

- **The Clock Metaphor Emerges:** The mechanical **clock** was one of the marvels of late medieval technology. By the 14th century, large weight-driven clocks were being installed in town squares and cathedrals across Europe, providing a public display of precise, regular motion. The clock became a powerful symbol of order and regularity. Soon, thinkers applied it to the heavens. Nicole Oresme and other 14th-century scholars, interpreting Aristotle, used clockwork analogies for the cosmos. By the time of **Copernicus (1543)** and **Galileo (early 1600s)**, the idea that the universe operates like a

precise clock, set in motion by the Creator, was gaining traction. Galileo famously wrote that "Mathematics is the language with which God has written the universe" – an idea akin to saying the universe is *designed with the precision of a geometric diagram or mechanism*. The culmination of the clockwork metaphor came with **Isaac Newton (1687)** and his peers. Newton's laws depicted a solar system that runs predictably under gravity's force, like clock gears turning. Though the phrase "clockwork universe" was attributed to later commentators, Newton's *Principia* solidified the notion of nature as a lawful machine. In a Newtonian world, each planet's motion is as regular as a pendulum's swing. The mechanical philosophy of that era explicitly *rejected* older Aristotelian notions of intrinsic purposes or souls in nature (what were called *"substantial forms"*). Instead, all physical phenomena were to be explained by matter in motion, contacting other matter – *the way gearwheels push each other* [25] [26] . In the 17th century, philosophers like **René Descartes, Pierre Gassendi, and Thomas Hobbes** championed this mechanistic ontology. Descartes, for example, argued that even living bodies (of animals and humans) are fundamentally machines. He famously wrote that the operations of living creatures "follow from the mere arrangement of the machine's organs every bit as naturally as the movements of a clock or automaton follow from the arrangement of its counter-weights and wheels" [27] . Here, Descartes explicitly compares passions, memory, and imagination – facets of life previously attributed to an immaterial soul – to the workings of clockwork. This marked a dramatic shift: **the dominant metaphor for life was no longer breath or spirit, but mechanism and automation**. (Descartes did except the human rational soul as non-mechanical, but he still saw the body itself as a machine [28] .) The clock, a product of human ingenuity, had by now supplanted the potter's wheel or the musician's lyre as the guiding image for reality.

- **God as Engineer vs. God as Animator:** In medieval thought, God was often seen as an artisan – the Great Potter or the Weaver of the World – but with the new science, a subtle change occurred. God was recast as a master *engineer or watchmaker*. The role of God shifted from continuous sustainer (breathing life into everything at each moment) to an initial designer who built the cosmic machine and let it run. This deistic image was articulated well by later figures like **Voltaire** and **Laplace**. A famous anecdote relates that when Pierre-Simon Laplace presented his celestial mechanics to Napoleon and was asked about the role of God in his system, Laplace replied, "I had no need of that hypothesis." Whether apocryphal or not, the story captures the sentiment that, once the cosmic clockwork was understood, invoking divine intervention was seen as unnecessary for the day-to-day running of the universe [29] . God had been, in effect, *upgraded to a clockmaker who built a perfect mechanism and stepped away*. This was a sharp turn from medieval Christian theology where God's presence was intimately woven into every natural event. Critics from religious perspectives noted this drift: they complained that the mechanical philosophy "seems to make God's intervention… unnecessary" and that viewing God as merely a skilled designer who tuned the world like a clock conflicted with the active, providential God of Scripture [29] . In effect, **mechanism desacralized nature** – physical matter could now be seen as dead, inert stuff moved only by external forces, rather than imbued with inner spirit or purpose. This was indeed a revolutionary reconceptualization of ontology. The previous "enchanted" worldview was gradually disenfranchised; the four elements (earth, water, air, fire) that once formed the tapestry of nature were replaced by **particles and forces** in a void. By 1700, leading scientists viewed the ancient element theory as naive – there were not four fundamental substances, but myriad chemical elements and atomic building blocks, all operating by the same mechanical laws. The old idea of *qualities* (hot, cold, wet, dry) gave way to quantitative measures like mass, temperature, and pressure.

- **Automata and the Rise of Causal Reasoning:** Another technological wonder of the Renaissance was the construction of complex **automata** – self-moving machines often designed to imitate living beings. Skilled clockmakers built mechanical birds that could sing, or mechanized figures that played musical instruments. These automata were precursors to robots, fascinating the public and philosophers alike. If a clever inventor could make a lifelike moving doll, was it not plausible that God made the vastly more complex "automaton" of the human body? Descartes indeed argued that animals *are* automata – fleshy machines without souls – and that much of human behavior could be explained mechanistically. The mechanists insisted that for any phenomenon, one should seek a **causal chain** of material interactions rather than invoke mysterious essences. This systematic cause-and-effect mindset was bolstered by the tremendous success of Newtonian physics in predicting motions. As one encyclopedia puts it, by the end of the 17th century many believed **"all phenomena could eventually be explained in terms of mechanical laws…implying a thoroughgoing determinism: if all events obeyed these laws, then the future would be as predictable as the ticking of a clock given perfect knowledge"** [26] [30]. The French mathematician **Laplace** epitomized this view in 1814 when he imagined an intellect (now known as *Laplace's Demon*) that knows all forces and positions; such an intellect "could condense into a single formula" the motions of the universe, and for it "nothing could be uncertain; the future, like the past, would be present before its eyes" [31]. This breathtaking claim underscores how completely the machine metaphor had taken hold – the universe was effectively a giant predictable engineering system. In that world-picture, *free will* and *vital spirit* seemed to have no place (leading to centuries of debate and, eventually, to new ideas in quantum physics and chaos theory that would challenge strict determinism). But for the Enlightenment era, **certainty through calculation** was the promise of the mechanistic paradigm. It is no coincidence that this period also saw the first mechanical calculators (Pascal's 1650s adding machine, etc.) and the systematic development of calculus itself as a tool to compute change. The mindset of **"everything is calculable and follows laws"** was reinforced by technology's visible success – pumps reliably lifted water, cannons obeyed parabolic trajectories, planets followed Kepler's ellipses. Thus, by the 18th century, intellectuals increasingly saw earlier worldviews – Aristotelian teleology, alchemical essences, astrological harmonies – as hopelessly misguided if not outright superstitious. Voltaire mocked the four elements, quipping that modern chemistry had found far more than four. In short, **the past was wrong; now we have the machine truth** – that was the attitude.

- **Survivals of Old Metaphors:** It's worth noting that while the mechanistic view triumphed in educated circles, older metaphors did not vanish overnight. People still spoke of the "spark of life" or the "breath of life," and religious language of God "animating" creation persisted. Even Newton entertained theological ideas (like God periodically adjusting the solar system's stability). However, as science progressed, even life processes were gradually mechanized. In the 18th and 19th centuries, the field of biology went through debates of **vitalism vs. mechanism**. Vitalists held that living organisms have a non-physical essence (a life-force) beyond mere chemistry, whereas mechanists argued that biology ultimately follows the same physical laws as inanimate matter. The mechanists won out in mainstream science, especially after milestones like Friedrich Wöhler's 1828 synthesis of urea (showing an organic substance could be made from inorganic precursors, undermining the idea of a special "vital chemistry"). By the Victorian era, many scientists viewed the human body unequivocally as a biochemical machine and the brain as an organ that, while astonishingly complex, operated under electrochemical principles. The **heart** was understood as a pump (William Harvey's discovery of blood circulation in 1628 was influential here, as he likened the heart's function to a mechanical pump with valves). The **lungs** were bellows, the **nerves** were wires carrying impulses.

Each analogy came from technologies of the time: for example, as knowledge of electricity spread in the 18th century, experiments showed muscles twitch under electrical stimulation, leading to speculation that "animal electricity" drives motion. Thus, early **electrophysiology** dovetailed with the mechanistic view, replacing ancient pneumatic spirits with electrical signals (a new metaphor: the body as an electrical machine rather than a clockwork – but still a machine). We see here the adaptability of the mechanistic paradigm: it could incorporate new tech metaphors (clockwork, hydraulic pumps, electrical circuits) as they became available, all under the umbrella idea that *living systems are built of moving parts and forces, nothing more*. By the late 19th century, the success of mechanistic science was so total in physics and chemistry that **Lord Kelvin** could declare there were essentially no mysteries left in those fields (an infamous statement just a few years before quantum mechanics and relativity upended things). The confidence was rooted in how far the machine model had taken us.

In summary, the period from the Renaissance through the Enlightenment represents the **mechanization of the world-picture**. The latest technology – mechanical contraptions with gears and later steam engines – became the dominant template for explaining reality. Natural philosophers shed the "woo-woo," as the user put it, of the previous era: gone were elemental sympathies, cosmic breaths, and musical harmonies as serious physics. In their place were **mass, force, and cause-effect chains**. The **philosopher became the scientist**, speaking in the language of mathematics and mechanism rather than allegory and myth. And indeed, each new generation often portrayed the previous worldview as somewhat foolish or childlike: *How quaint that they thought the world was made of earth, air, fire, water – now we know it's atoms and energy!*; *How naive to think the heart is the seat of emotions – it's just a pump!* and so on. This rhetoric of progress through better metaphors would continue.

Yet, even as the mechanistic paradigm reached its zenith in the 19th century, new cracks in its completeness were forming. The Industrial Revolution ushered in not only bigger and better machines, but also concepts like **energy, entropy, and information** that would, in time, demand new explanatory frameworks. We turn next to the 19th century and the rise of thermodynamics – an area where the machine analogy began to confront its own limitations and point toward the next metaphorical revolution.

The Industrial Age and Thermodynamics: The World as Engine and Entropy

By the 1800s, the Industrial Revolution was in full swing, and steam engines were the emblematic technology of the age. Factories, locomotives, and mechanized power transformed society. It is no surprise that this era's scientific and philosophical thinking was heavily influenced by concepts related to **engines, energy, and efficiency**. Two key developments defined the 19th-century scientific worldview: **thermodynamics** (the study of heat, work, and energy conversion) and **evolutionary theory** in biology (which, while about life, was deeply influenced by the era's emphasis on progress and competition – not a machine per se, but certainly an idea of systematic development). In this section, we focus on thermodynamics and the metaphor of the universe as a kind of heat engine – a perspective that introduced the inexorable concept of *entropy* and the fate of "heat death," thereby somewhat altering the pure clockwork optimism of earlier decades.

- **Nature as a Heat Engine:** Early thermodynamicists such as Sadi Carnot (1820s) studied the efficiency of steam engines – how heat could be converted to work. From these practical inquiries

came general laws: energy is conserved (first law of thermodynamics) and heat naturally flows from hot to cold, increasing entropy (second law). Scientists soon generalized these beyond engines to the entire universe. If the **universe is an isolated system**, they reasoned, it too should follow the second law and wind down to a state of maximum entropy. Thus was born the idea of the universe as a **gradually cooling engine**, slowly dissipating its useful energy. In 1854, William Thomson (Lord Kelvin) articulated the idea of the **heat death of the universe**: eventually, all energy will be evenly spread out as waste heat, no more work can be extracted, and the cosmos will reach thermodynamic equilibrium [32] [33]. This was a striking shift in cosmic narrative. The clockwork universe of Newton was eternal and cyclic; it didn't predict an end state. But the thermodynamic universe had a built-in direction: an **"arrow of time"** given by entropy increase [34]. The adoption of this concept in Victorian times had broad implications. It introduced a certain pessimism or melancholy in philosophical outlook – the idea that all complex structures (including life) must eventually run down. The Victorians indeed discussed heat death in both scientific and theological contexts [35] [36]. Here, then, was a metaphor of an **engine running out of steam** applied to the cosmos. One might say the 19th-century worldview imagined the universe as *a grand steam engine that will one day exhaust its fuel*. Notably, this scenario was a direct extrapolation from the era's cutting-edge machines. An engineer watching his coal-fired engine would see that without new coal, eventually the fire cools and the engine stops – how natural to extend that to the cosmic engine. In a way, this was still a mechanistic view, but it added a new element: *irreversibility*. Clocks can be wound up again; a perfect Newtonian mechanical system doesn't lose energy (since in classical mechanics energy is conserved and, without friction, perpetual motion of planets is possible). But the **steam-engine universe** does have friction, dissipation, and one-way progress toward disorder. This metaphor was very powerful and persists in contemporary physics (the heat death remains the leading expectation for the far future given our current understanding of physics). The second law was even called the *"fatal law"* by some thinkers, emphasizing its remorselessness.

- **Energy and Information:** The 19th century also unified the concept of energy. Where earlier scientists spoke of different "forces" (gravity, electricity, chemical affinity), by mid-century they realized these were all forms of one thing: energy. The law of **energy conservation (First Law)**, formulated by Hermann von Helmholtz and others around the 1840s, became a cornerstone. Energy took on an almost mystical omnipresence – it could neither be created nor destroyed, only transformed. In some philosophical circles, energy was essentially the new "spirit" of the world, an invisible substance that powered everything. Thomas Huxley, for instance, wrote that we are just "transformers of energy" in our vital processes. One interesting precursor of viewing the world in terms of **information** comes indirectly from thermodynamics: physicists began noticing the link between *entropy* (a thermodynamic measure of disorder) and *missing information*. In 1867, James Clerk Maxwell conceived his famous demon thought experiment, implicitly tying entropy to knowledge. Later, in 1877, Ludwig Boltzmann gave a statistical interpretation of entropy as related to the number of microstates (disorder) – which much later (in the mid-20th century) was recognized as essentially an information count (Shannon actually borrowed the term "entropy" for his information theory in 1948 due to the formal analogy). Thus, by the end of the 19th century, the seeds were sown for thinking of **nature in terms of information processing**, though this would not flower fully until the next century. There's an illustrative line in a modern Britannica entry: "a completely random dispersion of elements corresponds to maximum entropy, or minimum information" [37] [38]. The fact that an encyclopedia casually equates entropy with lack of information shows how thoroughly the 20th-century synthesis has fed back into describing 19th-century concepts. But in the Victorian

era itself, this connection was only dimly appreciated; they were more concerned with energy as a fluid-like conserved quantity and entropy as its inevitable degradation.

- **Society and Mind as Machines:** The dominance of mechanistic and industrial metaphors also affected how people thought about society and mind. In sociology and economics, 19th-century thinkers often sought *laws* analogous to physical laws. For example, some economists described the economy as a machine or saw **labor in terms of energy** (the labor theory of value in Marx has some resonance with energy expenditure). The idea of **"social engineering"** – that society can be engineered or designed rationally – gained popularity by late 19th and early 20th century (e.g., utopian thinkers and later technocrats). Meanwhile, psychology in the late 1800s started to break from philosophy and align with physiology, treating the brain as an elaborate machine. We see early computational analogies: e.g. **Hermann von Helmholtz** compared the mind's workings to telegraphy and hydraulics; **Sigmund Freud** in 1895 described a *Project for a Scientific Psychology* using a crude neural network model and borrowed concepts from thermodynamics (speaking of psychic energy, pressure, and discharge – essentially a hydraulic model of the psyche). These are examples of how, even before modern computers, *industrial-age machinery* informed theories of non-physical domains. The brain was likened to a telegraph network or a complex switchboard – metaphors taken from the latest communication tech of the 19th century. Notably, by the end of the 19th century, **telephone exchanges** with their tangled wires became a metaphor for the brain's neuronal connections. Each era thus not only applied metaphors to the cosmos but also to *human nature itself*. And typically, the human was seen as less special with each turn: first a clay infused by divine breath (sacred art), then an animal with a soul, then a complex machine of flesh, then essentially a thermodynamic engine consuming energy, and by the 20th century perhaps an *information processor* (as we shall see).

- **Challengers to Mechanism:** The 19th century also had intellectual movements that reacted against stark mechanism. The Romantic movement in art and philosophy decried the reduction of nature to mere machine; they emphasized spirit, organic growth, and the mysterious sublime (e.g., Goethe's science focusing on holistic development rather than analysis into parts). There were also spiritualist and occult revivals (e.g., Mesmer's "animal magnetism," Theosophy, etc.) that implicitly protested the soulless machine narrative. However, in mainstream science these had little effect – the momentum of mechanistic thinking continued, largely because it *worked* so well for producing concrete results (railroads, electric lights, chemical industries, etc.). By 1900, the success of the mechanistic-industrial worldview was undeniable on a practical level, even if some yearned for a reconnection to meaning beyond the gears.

In summary, the Industrial Age took the clockwork paradigm and supercharged it with steam and steel. **Nature was an engine**; understanding its fuel (energy) and its exhaust (entropy) became central. The world was increasingly seen as a **closed system of transactions** – be it energy conversions or competitive survival (in Darwin's theory, which was influenced by industrial-era thinking like Malthusian economics and breeders' artificial selection practices). By the end of the 19th century, many scientists would have agreed with the assertion that the universe is like a **giant heat engine winding down** [32]. The earlier clock metaphor hadn't been invalidated, but it had been amended: a clock is too ideal (no friction, no loss), whereas an engine with finite fuel captures the new awareness of irreversibility.

Little did they know that just as they felt close to "figuring it all out," new revolutions were around the corner. The early 20th century brought **relativity and quantum mechanics**, which would shatter some

mechanistic intuitions (absolute time, strict determinism) and introduce new potential metaphors (like the *observer* into physics, and the wave-particle duality). And mid-20th century would then bring the *information revolution*, once again reframing how we conceptualize reality's bedrock. We now turn to these 20th-century developments: how the rise of computers, information theory, and quantum physics created a fresh set of analogies – casting the universe not as a steam engine, but perhaps as a **computer or an information processing system**.

The Information Age Paradigm: The World as Information, Code, and Computer

The mid-20th century saw another transformative shift in the metaphors of science and philosophy, driven by rapid advances in **communication, computation, and quantum physics**. With the invention of digital computers, the formulation of information theory, and the peculiar discoveries of quantum mechanics, thinkers began to describe the brain, the universe, and life itself in terms of **information processing and computation**. The notion that "the world is made of information" or that nature is fundamentally *digital* gained currency. This era, roughly from the 1940s onward, could be called the **Information Age worldview**, and it set the stage for many of the ideas currently in play (such as simulations and AI). Let's break down the key components of this paradigm:

- **Claude Shannon and the Birth of Information Theory (1948):** In 1948, Claude Shannon published "A Mathematical Theory of Communication," introducing the concept of *bit* (binary digit) as the fundamental unit of information and defining *information entropy* to quantify uncertainty or surprise in messages. This seemingly specialized work (for telephone communications) had profound implications. It treated information as an abstract quantity that can be measured like energy. Shannon's theory showed that any message – whether text, sound, or image – could be encoded in bits, and that redundancy and noise could be managed with error-correcting codes. This not only launched digital communications; it also provided a new metaphor for understanding order and disorder. Scientists noticed that Shannon's formula for information entropy closely resembled Boltzmann's formula for thermodynamic entropy. This hinted at a deep link: **entropy in physics might literally be missing information at a microscopic level**. Over time, this led to ideas like **"Maxwell's Demon" being resolved by considering the demon's information,** and **Leon Brillouin's principle** that gaining information about a system increases entropy elsewhere by at least an equivalent amount (tying information to thermodynamic cost). The upshot was a creeping sense that *information is as fundamental as matter and energy*. Physicist **John Wheeler** famously encapsulated this with the phrase **"It from Bit"** – meaning every physical "it" (particle or field) at bottom arises from binary choices, from bits [39] [40]. In a 1989 paper, Wheeler argued "all things physical are information-theoretic in origin" [1]. In other words, *the universe is fundamentally made of information, with matter and energy as incidental manifestations*. This was a bold ontological claim, essentially flipping the old materialist view on its head. Instead of information being a property of arrangements of matter, matter itself (the "it") was to be seen as a product of information ("bit") [41]. Such a view would've sounded abstruse in 1900, but by 1989 the success of digital technology and quantum information experiments gave it credibility. Wheeler's "it from bit" is often cited to illustrate the Information Age worldview: one where **reality is at root computational or informatic** [1].

- **Cybernetics and Systems Thinking:** Parallel to Shannon's work, **Norbert Wiener** and others developed *cybernetics* in the 1940s – the science of control and communication in animals and

machines. Cybernetics introduced concepts like *feedback loops*, *information flows*, and *homeostasis*, applying them universally to biological, mechanical, and social systems. Wiener explicitly saw organisms as information processors and even defined "information" as "information is information, not matter or energy. No materialism which does not admit this can survive at the present day," highlighting that it was a new irreducible concept. Cybernetics influenced fields from neuroscience to economics, encouraging researchers to model **brains as networks of signaling units** and **societies as regulated systems**. The notion of *feedback* was a major new metaphor: rather than simple linear cause-effect, systems could have circular causality (output fed back as input), enabling self-regulation and goal-seeking behavior in machines (e.g. guided missiles) or organisms (e.g. maintaining body temperature). This presented a more *dynamic* view of mechanism, one that could mimic purposeful action. It was an important step in bridging the gap between life and machine: a thermostat-guided heating system could *imitate* a simple life function (keeping temperature constant) via feedback. Suddenly, the **line between animate and inanimate blurred further** – now machines could "sense and correct" their behavior autonomously, in a way analogous to living organisms responding to the environment. People started describing the brain and even society in cybernetic terms: the brain was like a computer (taking inputs, processing, outputting commands) and society was like a collection of feedback-regulated subsystems (economist Walter Cannon earlier had spoken of the "body economic" with homeostatic features, etc.).

- **The Brain as a Computer (Cognitive Revolution):** With the advent of actual electronic computers in the 1940s (ENIAC and successors) and especially the rise of computer science in the 1950s–60s, it became increasingly common to compare the *human brain/mind to a computer*. This was not just a loose analogy; it became a formal research program in cognitive science and artificial intelligence (AI). The **Computational Theory of Mind**, or functionalism, posited that *mental states are computational states*. Philosopher Hilary Putnam and others argued that the mind is to the brain as software is to hardware [42]. In this view, the actual wetware (neurons) mattered less than the logic of the computations being carried out. As one summary put it, *"The proper way to think of the brain is as a digital computer. Our psychology is to be described as the software of this computer – its functional organization."* [42]. Such statements from the 1960s–1970s reflect how deeply the computer metaphor took hold in understanding ourselves. The **mind-as-computer** idea was a natural progression from earlier analogies (brain as telegraph network, etc.), but now actual programmable machines existed to make the comparison concrete. AI pioneers like Allen Newell and Herbert Simon created programs that mimicked problem-solving, suggesting that reasoning was basically rule-based symbol manipulation – exactly what computers do. This wave produced the language of "processing information," "memory storage," "inputs and outputs," etc., to describe cognition. The success of this approach in explaining aspects of thinking (and in developing AI that could perform tasks like proving theorems or playing chess) solidified the metaphor. By the 1980s, even popular culture often depicted the brain as an organic computer and talked of "reprogramming" ourselves or "hard-wired" instincts. It's important to note this metaphor is still dominant today in neuroscience and psychology, though with refinements (e.g., the brain is not a *serial* binary computer but a massively parallel device, etc.).

- **DNA and the Genetic Code:** Another information-centric development was the discovery of the DNA structure (1953) and the cracking of the genetic code. Biologists quickly adopted informatics terms: DNA was a **code** made of letters (A, C, G, T nucleotides) carrying instructions for building proteins. They described it as a "blueprint" or "program" for life. The molecular biology revolution thus reinforced the worldview that *information underlies life's processes*. Life was not driven by an

unknowable vital force, but by biochemical machines following digital instructions encoded in genes. This was essentially treating organisms as biological computers at the molecular level – the genome as the software, the cellular machinery as the hardware executing it. By the 1970s, the central dogma ("DNA makes RNA makes protein") was well established, and terms like "genetic information" and "transcription/translation" (literally borrowing language from communication theory) were standard. Some scientists even mused that a cell's complexity might be akin to a Turing machine or that evolution is an information processing algorithm optimizing genetic code. The union of biology with information theory went so far that **physicist Erwin Schrödinger**, in his 1944 influential book *What is Life?*, presciently talked about an "aperiodic crystal" carrying genetic information – essentially predicting DNA and framing it in information terms before it was discovered. So when it came, it slotted neatly into the Information Age mindset.

- **Quantum Mechanics and Information:** The early 20th-century breakthroughs of **quantum mechanics (QM)** and **relativity** initially didn't have an obvious technology analogy (they were more math-driven conceptual revolutions). But as quantum theory matured, especially by mid-century, people started drawing new metaphors from it too. One such metaphor was the idea of the **observer effect** – that at quantum scales, the act of measurement (information gathering) irreducibly affects the system. Some philosophically interpreted this as consciousness or knowledge being woven into the fabric of physics (though most physicists see it as measurement devices interacting, not human consciousness per se). Nevertheless, it suggested reality isn't a detached clockwork; information and observation play a role in how reality manifests (e.g., collapse of the wavefunction). Later, in the 1970s–80s, physics discoveries like **black hole entropy** (by Bekenstein and Hawking) and **quantum information theory** started merging QM with information ideas. Black hole thermodynamics implied that black holes have an entropy proportional to their surface area, hinting that information is stored on surfaces – a clue leading to the **holographic principle** (discussed below). Furthermore, in 1960s–1980s, people like **Rolf Landauer** established that *information erasure has a thermodynamic cost* (Landauer's principle: erasing a bit of information releases kT ln2 energy as heat). This was concrete proof that information is not abstract; it is physical. *"Information is physical,"* Landauer declared – meaning you can't have information without it being embodied in a physical state [43]. This principle and related experiments cemented the legitimacy of treating *information as a quantity conserved or implicated in fundamental laws* similar to energy. By the 1980s, some started to speculate that perhaps physics itself could be rebuilt from information concepts. Indeed, **John Wheeler's 1989 "it from bit" talk** came at this time, and shortly after, people like **Edward Fredkin, Konrad Zuse, and Stephen Wolfram** would explore the idea of *digital physics*: that maybe the universe at the smallest scale is like a cellular automaton or a giant computer running a program [44]. We see here an interesting full-circle: where the mechanists had thought of the world as a mechanical clock, the digital physicists thought of it as a **cosmic computer** crunching state updates. Konrad Zuse, a German computer pioneer, wrote a book in 1969 (*Rechnender Raum*, "Calculating Space") proposing that spacetime might be a grid of computing cells – essentially the first explicit **simulation hypothesis** in physics [44]. These ideas were fringe at first, but gained a bit more attention as computing power grew and as certain physical puzzles (like quantum indeterminacy or the nature of space-time) tantalizingly suggested discrete informational underpinnings.

- **"The Universe as Computer" and Digital Metaphysics:** By the late 1990s and 2000s, talk of the universe as a computer entered even popular science books. For instance, **Seth Lloyd** (MIT quantum scientist) wrote *Programming the Universe* (2006) arguing the universe is literally a quantum

computer computing its next state. He famously said, *"The universe is a computer. The Big Bang was the 'Bit Bang'."* [43], implying that at creation, bits of information came into existence just as space, time, and energy did. Lloyd estimated the computational capacity of the universe (on the order of 10^120 ops, etc.) as a way to back such claims. Another theoretical physicist, **Gerard 't Hooft** and **Leonard Susskind**, developed the **Holographic Principle** in the mid-1990s. This principle – later exemplified by Maldacena's AdS/CFT duality in 1997 – posits that all the information about a volume of space can be encoded on its boundary surface (like a hologram encodes a 3D image on a 2D film). In essence, it suggests that our apparently 3D world might be a kind of projection of underlying information on a distant 2D boundary [45] [46]. This is sometimes sensationalized as *"the universe is a hologram."* While the technical meaning is subtle (and the popular phrase is an oversimplification [47]), it captured imaginations because it's a very information-centric view: spacetime geometry and gravity might emerge from informational entanglements on a lower-dimensional space [48] [49]. It also metaphorically harkens back to the **concept of illusion or Maya** in Eastern philosophy – the idea that the world we see is a projection. The difference is now it's a concrete physics conjecture, not just an allegory.

- **Simulation Hypothesis:** A direct extension of the "universe as computation" idea is the **simulation argument**. In 2003, philosopher **Nick Bostrom** proposed a formal argument that if advanced civilizations can run very realistic simulations of conscious beings, and if they would actually do so in great numbers, then it is highly likely that we ourselves are in such a simulation (because simulated beings would vastly outnumber original "real" beings) [50]. Bostrom's argument put philosophical rigor behind a concept that had been floating around in science fiction (e.g., *The Matrix* film appeared in 1999, popularizing the idea that perceived reality might be a computer simulation). The simulation hypothesis essentially says: *the ultimate metaphor isn't that the universe is like a computer program – it's that it is a program, running on some higher reality's machine.* This is a radical reimagining of "what is real," enabled entirely by the rise of computing technology. It's telling that no ancient philosopher ever suggested the world is a simulation or virtual reality – you need to have invented computers and seen their capabilities to even conceive that. Bostrom's idea sparked widespread debate. Some scientists like cosmologist Paul Davies and physicist Silas Beane have speculated on ways to test if we're in a simulation (e.g., looking for pixelation of space or anomalies in cosmic ray distributions as "resolution limits"). While there's no evidence we are simulated, the discussion itself indicates how far the computer metaphor has permeated thought. Public figures like Elon Musk have casually asserted "most likely we're in a simulation," reflecting a growing acceptance of the plausibility of this view in tech circles.

- **The Mathematical Universe and Abstract Information:** Another strand worth mentioning is the philosophical view that **reality is fundamentally mathematical**. This is akin to saying reality = information, since mathematics is basically pure information/structure. **Max Tegmark**, an MIT physicist, has championed what he calls the **Mathematical Universe Hypothesis (MUH)**. He argues that the external physical reality *is* a mathematical structure, not just described by math but literally made of math [51]. In his words, "our universe isn't just described by mathematics – it **is** mathematics, in the sense that we're all parts of a giant mathematical object" [51]. This extreme Platonist view holds that every mathematical structure exists equally, and we happen to inhabit one that is complex enough to contain self-aware substructures like us [52]. Tegmark's idea, while controversial and not empirically testable, beautifully exemplifies the Information Age mindset: **everything is abstract information, with physical existence being just one way information manifests**. It's the ultimate vindication of Pythagoras (who saw numbers behind reality) updated

with modern cosmology. Tegmark's hypothesis basically treats the universe as a kind of giant data structure or geometrical object – consonant with Wheeler's "it from bit" since math and bits are closely related (a bit is just a choice between 0/1, i.e., a basic mathematical distinction).

In summary, the mid/late 20th century wrapped the world in a new metaphorical fabric: that of information and computation. The human brain became a computer, DNA a digital code, physical processes computations, and the whole universe a kind of information processor. Earlier ages saw the cosmos as a machine, but now it was specifically a *computerized* machine, possibly with a code (laws of physics as algorithms, initial conditions as input). This has led to some truly novel philosophical notions: e.g., **maybe energy is just a form of information** (since we can equate entropy with missing information, some have mused whether even what we call energy might be an emergent aspect of information – though this remains speculative). Another notion: **maybe consciousness itself is information** (as in integrated information theory of consciousness by Tononi, which quantifies consciousness by the amount of integrated information ϕ in a system). We see the information paradigm seeping into every discipline: economics talks about information economies, biology sees ecosystems as information networks, physics considers entropy/information duality, and computer science metaphors are everywhere (people talk about the "algorithm of life" or "the code of the universe").

Importantly, as with previous paradigm shifts, proponents of the new view sometimes disparaged the prior era's concepts. In the mid-20th century, you can find scientists ridiculing purely mechanistic or vitalistic explanations as outdated. For example, early AI proponents in the 1960s were quite dismissive of behaviorist psychology (which treated the brain as a black box responding to stimuli, a kind of mechanical input-output with no internal info processing). They labeled it insufficient and replaced it with the cognitive (computational) model. Similarly, some information-centric physicists started to say things like "field and particles are secondary; bits are the real thing" – effectively saying the mechanical concept of solid particles or continuums was incomplete.

However, it's worth noting that each new metaphor doesn't so much falsify the previous as subsume and extend it. Mechanical laws still apply; engines still run. But now they are seen as *implementations* of information processing or particular cases within a larger information-based framework. For instance, a clock can be seen as a device that processes information about time (the position of its hands encodes the time). Likewise, a steam engine's piston motion and heat flow can be described informationally (the engine's state has such-and-such entropy, etc.). So, while the metaphors shift emphasis, in hindsight they often appear compatible at some level.

We have now arrived at the present (early 21st century) where information metaphors reign. Yet, already we see new phenomena that challenge us to find even fresher ways to conceptualize the world. The rise of artificial intelligence, especially **large language models (LLMs)** like GPT-3 and GPT-4, along with advances in **quantum computing** and deeper mysteries in physics (quantum gravity, dark matter/energy), are prompting us to imagine new analogies. The user specifically alluded to how AI reveals language as a kind of self-organizing principle and how quantum ideas might lead to notions like "the brain is a quantum computer" or "the universe is a hologram." In the next section, we will explore these emerging ideas – effectively peering into the future to guess how the "philosophers of tomorrow" might lean on today's cutting-edge tech to explain everything.

The Emerging AI/Quantum Era: Reality as Algorithm, Language, or Hologram

Standing at 2025, we can observe the early contours of what might become the next dominant worldview. Two technological/scientific currents stand out: **artificial intelligence (especially in the form of machine learning and language models)**, and **quantum science** (quantum computing, entanglement, and related theories that blur lines between information and reality). Pioneers in these fields are already suggesting metaphors that could revolutionize our conception of mind, cosmos, and existence, much as the clock or computer did in earlier times. While it's too early to say which ideas will stick, we can discern a few themes:

- **Language and Intelligence as Fundamental:** One of the surprising lessons of modern AI research is that *language itself contains extraordinary power*. Large Language Models (LLMs) like GPT have demonstrated abilities (coding, reasoning, creativity) that were not explicitly pre-programmed, but *emerged* simply from absorbing vast amounts of human language data. For example, models have learned to perform arithmetic, answer complex questions, and write computer code, all **"simply by observing natural language"** during training [53]. These capabilities appear spontaneously once the model reaches a certain scale – an instance of **emergent behavior** [54]. It is as if the structure of language encodes patterns of reasoning about the world, so by internalizing language, the AI also internalizes a broad range of knowledge and skills. Some researchers noted that scaling up language models leads to **"the sudden appearance of novel behavior"**, with abilities appearing "as if emerging out of thin air" at certain critical model sizes [53] [55]. This has prompted philosophical reflection: perhaps *language is more than a communication tool; perhaps it is a repository of intelligence or a structure that mirrors reality*. Consider that humans learn as children largely by absorbing language from others – we don't explicitly program babies with physics formulas or logic axioms, yet through language and experience they acquire sophisticated understanding. Now AI models mirror this. One might argue, somewhat provocatively, that **language itself is an organism or an evolving entity**, one that uses humans (and now AIs) as hosts to propagate meaning. This echoes ideas from memetics (Richard Dawkins' concept of memes as self-replicating units of culture) but takes it further: seeing language as a *self-organizing system that can generate complexity without having explicit grounding in external reality*. The user mentioned "language seems to be a self-reproducing entity. It doesn't seem to need to know the structure of programming to be a good programmer... doesn't need to know fundamental gravity to do things." Indeed, GPT-4 can write working code in Python without ever having been given the rules of Python; it simply inferred them from patterns in text. Similarly, it can answer physics questions correctly without "knowing" Newton's laws in an explicit way, but by having seen enough text about physical situations. This suggests a potential future worldview: **reality as fundamentally linguistic or informational, with syntax generating semantics on its own**. This is almost mystical: it recalls the Gospel of John ("In the beginning was the Word (Logos), and the Word was with God, and the Word was God") or Indian philosophies where *Om* (sound) underlies creation. Could it be that modern AI is resurrecting an ancient intuition in new form – that *structure (form) precedes content (meaning)*, or that *word/logic underlies matter*? Some might say we are seeing evidence that once a sufficiently rich symbol system (like human language) is in place, *intelligence can emerge from the interplay of those symbols alone*, without direct interaction with physical reality. This of course is debated – many argue the AI doesn't "truly understand," it's just statistical pattern matching. But as AI systems become more competent, the line between genuine understanding and clever mimicry blurs. We may reach a point where philosophers declare that **meaning itself is just an emergent property of symbol manipulation**. That would be a profound shift: it would prioritize *relation and structure* over *material substrate*.

- **The Brain as Quantum Computer (and Consciousness):** While classical computational metaphors have dominated neuroscience for decades, there's a growing fringe (and some mainstream interest) in the idea that quantum processes might play a role in the brain and consciousness. The most notable proponents are **Sir Roger Penrose and Stuart Hameroff**, who developed the Orch-OR (Orchestrated Objective Reduction) theory. They controversially argue that quantum coherence in microtubules (tiny structures in neurons) contributes to consciousness, effectively that **the brain works as a quantum computer** and that conscious moments relate to a quantum gravity-related collapse of the wavefunction in these microtubules [2] [56]. While this theory is not widely accepted (and critics point out the brain is warm and wet, usually hostile to sustaining delicate quantum states), research in quantum biology (e.g., quantum effects in photosynthesis, bird navigation) has shown that not *all* quantum coherence is washed out at biological scales. Moreover, the allure of quantum mind theories is strong because they promise to explain the mysterious features of consciousness (like why it's non-algorithmic, if one believes consciousness transcends computation as Penrose does). Already, the phrase **"the brain is a quantum computer"** appears in discourse, if not yet textbooks [2]. Should evidence accumulate for quantum effects in neurons, this could become a new dominant metaphor. What would that mean philosophically? Potentially that **consciousness and the cosmos are linked at the quantum level**, or that our minds tap into the fundamental probabilistic nature of reality. It might inspire a neo-pantheism where the "ground of being" is a cosmic quantum computation that our brains also partake in. This remains speculative, but it's notable that even the possibility is influencing thought experiments and popular culture (the term "quantum consciousness" is a buzzword in New Age circles already).

- **The Holographic and Networked Universe:** As touched on earlier, the holographic principle from physics provides a powerful new way to envision reality: as something like a **hologram or a network of information**. If our 3D world is actually a projection of 2D data on a distant boundary, it challenges our intuitive notion of space. It suggests that location and perhaps even individuality are emergent, not fundamental – since the "source" of reality might be encoding everything all together on a lower dimensional grid. Some have drawn analogy of the universe to a **neural network**. In fact, in 2020, physicist **Vitaly Vanchurin** published "The World as a Neural Network," positing that the entire universe on a fundamental level could be a learning algorithm, a self-training neural network [57] [58]. He showed that under certain assumptions, the equations governing a neural network's state evolution could mirror those of quantum mechanics and general relativity, hinting at a possible unification. This is still highly speculative, but intriguing. If the universe *learns* or *self-organizes like a neural net*, that is a very cutting-edge metaphor, directly inspired by the AI revolution. It implies things like natural selection might operate at cosmic scales, or that the universe might be *improving its own model of itself* [59] [60]. Similarly, as mentioned, thinkers like Sabine Hossenfelder have noted structural similarities between the cosmic web of galaxies and the network of neurons in a brain [61] [62]. While she doesn't claim the universe is literally thinking, she provocatively asked "Maybe the universe thinks? Hear me out." and highlighted how 10^15 connections in a human brain vs. 10^360 possible non-local connections in the universe (as estimated by some quantum gravity ideas) show that, in principle, the universe has an astronomically larger "connectome" than a brain [63] [64]. The speculation here is: could the universe itself have some form of intelligence or self-organizing principle at the largest scale? It sounds crazy, but we recall that in ancient times Anaxagoras posited a cosmic *Nous* (Mind), and Stoics spoke of anima mundi (world-soul). These ideas were edged out by mechanistic science. Now, ironically, cutting-edge science is allowing them to resurface in new guise, backed by mathematics: a connected universe with emergent order might not be conscious in a human sense, but can be thought of as **computing something – perhaps itself**.

- **Everything is a Simulation / Information:** If AI and quantum principles continue to advance, we might see a convergence of the simulation idea with internal physical perspectives. For instance, the universe could be seen as **a self-simulating system**. One radical recent proposal (by philosopher Joscha Bach, etc.) is that perhaps the universe is *"a simulation that is not being run on any external computer but on itself"*. This is a twist on the simulation hypothesis that avoids the need for an outside simulator – it suggests reality consists of patterns that reference and sustain each other, much like a strange loop (to borrow Douglas Hofstadter's term). This is highly theoretical, but it illustrates the appetite for a grand unified metaphor that combines computing, information, consciousness, and physics.

- **Rewriting Ontology with AI Insights:** As AI systems like GPT-4 demonstrate creative and problem-solving abilities, some thinkers argue this forces us to reconsider what intelligence and knowledge truly are. Already, debates rage: Does GPT-4 **understand** what it's saying or is it just a "stochastic parrot"? If in a few years an AI passes the Turing Test consistently and even achieves scientific breakthroughs, one might argue that *understanding* has been replicated by an alien substrate (silicon and algorithms). That could lead to philosophical positions like **functionalism on steroids** (all that matters is the right pattern of information flow, not the material) or even **panpsychism** updated (maybe consciousness is an emergent property of any sufficiently complex information processing network, which could include the internet or the universe). There is even a novel idea in analytic philosophy of mind called **illusionism** – the argument that our sense of conscious experience might be a kind of user-interface illusion generated by information processes, not a fundamental property. This kind of thinking dovetails with the AI perspective that if you simulate intelligence fully, there's nothing left over – the simulation *is* the thing.

- **Return of Ancient Metaphors in Scientific Language:** Interestingly, as we gain these new metaphors, we sometimes revive older ones but with a twist. For example, scientists now talk about the "**music of the cosmos**" in a literal way: detecting gravitational waves from black hole mergers and translating them to sound, or searching for frequency signatures in the cosmic microwave background. The phrase "the universe is music" gets a fresh scientific veneer when string theory says particles are vibrations of tiny strings (indeed, Brian Greene's popular book *The Elegant Universe* made much of the music analogy). The concept of a **"fabric" of spacetime** is mainstream in general relativity – Einstein pictured spacetime as a geometrical fabric that curves. That's essentially a weaving metaphor (we call it the "fabric" quite literally [14]). Moreover, the term "weave" appears in quantum gravity approaches – e.g., spacetime might be a weave of spin networks (in Loop Quantum Gravity). So weaving and music, two ancient metaphors, have reappeared at the cutting edge, mediated by the language of information (since waves are information carriers and networks are like woven webs).

We can foresee that a new class of philosophers and scientists will indeed proclaim a revised worldview, leveraging AI and quantum tech to do so. What might they say? Possibly things like: *"Consciousness is a quantum computation and our reality is one big quantum neural network – essentially, the universe is self-simulating and self-aware in a way we are part of."* Or *"Physical laws are emergent from the learning algorithm of the cosmos; information is the only currency, and matter is a state of information."* These sound fantastical now, but recall how fantastical "the earth moves around the sun" sounded in 1500, or "life is just chemistry" sounded in 1800, or "time slows down at high speed" in 1900. Yet those became accepted truths.

It's also likely that, consistent with the pattern, the new evangelists will critique the current paradigm. We might hear statements like: *"They thought the brain was just a classical computer – how laughably simplistic! It's actually a quantum-holographic processor tapping into cosmic information fields."* Or *"They believed reality was made of fixed particles – in fact it's made of entangled q-bits of information projected from a lower dimension."* In some futurist circles, such language is already present. The user specifically pointed out that when we move to a new world view, the proponents tend to portray the old one as "lost" or "had it all wrong." So we can expect, for instance, a certain dismissiveness toward pure materialism from those championing these new ideas. Perhaps terms like *"old paradigm Newtonian thinking"* will be used pejoratively (indeed, phrases like that are common in New Age and holistic communities when promoting quantum-consciousness ideas).

A concrete example: **Integrated Information Theory (IIT)** of consciousness, developed by neuroscientist Giulio Tononi, posits that consciousness is literally integrated information. According to IIT, even a small system that integrates information (in a technical sense) has a tiny bit of proto-consciousness, and the human brain, having a high Φ (phi) value, has rich consciousness. This theory is controversial, but it's an instance of a modern scientific hypothesis that **elevates information to the ontological forefront**, arguably echoing panpsychist ideas (mind in everything) in a mathematical form. If IIT or something like it gained wide acceptance, we'd basically be saying *consciousness = information structure*, dissolving the old dualism of mind vs. matter into just one substance: information (with mind being the "integrated" form of it).

Furthermore, **quantum entanglement** suggests that spatially distant objects can be deeply connected (what Einstein called "spooky action at a distance"). Some have poetically likened this to a **"weblike" interconnection** of all particles. If one takes a philosophical leap, one could say *maybe separateness is an illusion; fundamentally the universe is one entangled whole.* That sentiment edges toward Eastern philosophical notions of oneness, but now couched in quantum terms. It's easy to imagine popular science communicators in coming years pushing the idea that *"we are all connected as one quantum system,"* which, if taken literally, is false for everyday scales (decoherence stops that), but as a metaphor it could shape culture – much as the mechanistic metaphor shaped the industrial age mentality of separability and analysis.

Finally, we should note the **meta pattern**: each era extends the previous. If we articulate what the AI/quantum era worldview might be in one sentence: *The world is a self-processing, information-based system, where intelligence (or computational rules) is fundamental and physical reality (matter, energy) is a manifestation of an underlying informational code.* This would subsume the mechanistic view (machines are just one type of information system) and the energetic view (energy is conserved because of information symmetries, etc.), rather as the mechanistic view once subsumed the organic (machines can mimic organisms, etc.).

Conclusion: The Never-Ending Spiral of Metaphors

Surveying this grand timeline – from clay and breath to clocks, steam engines to computers, and now to AI and qubits – we see clearly that **human understanding of "reality" is deeply intertwined with the metaphors drawn from our most impressive tools**. Each technological leap doesn't just give us new capability; it gives us a fresh lens through which to interpret the entire cosmos and our place in it. Philosophers, scientists, and spiritual thinkers have consistently reached for the *highest technology of their time* as an explanatory model:

- In a world of **potters, weavers, and musicians**, creation was explained as pottery, weaving, or music crafted by divine hands or voices [7] [11] [20].

- In an age of **clocks and automata**, the universe became a precise clockwork set in motion by a clockmaker God [27].
- In the **industrial age**, the world became an engine – driven by energy and headed toward entropy [32].
- In the **20th century**, as we harnessed electricity, code, and logic circuits, the universe turned into an information processing system – something like a cosmic computer running laws as programs [1].
- Now, with **AI and quantum experiments**, we begin to imagine the world as perhaps a neural network, a quantum computation, or a kind of simulation rich in data and probabilities [3] [50].

Each metaphor did not totally erase the previous ones, but it *relegated* them. What was once taken literally (e.g., a literal breath of life from God) becomes poetic under a newer paradigm ("breath" might become a metaphor for unseen forces, but we no longer think actual air is what animates us). Likewise, under a possible future information paradigm, the idea of mechanical gears causing events might sound quaint – not wrong for clocks, but not deep enough to explain, say, why those gears exist or how time itself emerges.

Importantly, this historical perspective teaches us **humility**. Every generation is tempted to say "*Now* we've figured it out – those old ideas were silly." And indeed, each new paradigm *has* pierced the veil of ignorance further and given us more predictive power and control. However, each also eventually yielded to an even more encompassing view. The mechanistic laws of Newton were upended by the probabilistic, information-linked laws of quantum physics. And now quantum physics itself might one day be seen as just a piece of a larger puzzle (maybe something like a *computationally emergent multiverse*, who knows). We should therefore be cautious of any claims that we have reached the "end of science" or a Theory of Everything in a philosophical sense. History suggests that even a TOE in physics will be interpreted through metaphors and could be reframed by future conceptual revolutions caused by new tech.

There is also a cyclical irony: some of the newest ideas echo the oldest. The notion that *"the world is information"* or *"the universe is a giant thought"* in some ways brings us back to mind-centric or Logos-centric philosophies of antiquity (e.g., Plato's forms, Brahman as the cosmic mind, or Berkeley's idealism "to be is to be perceived"). After a long detour through hard mechanical objectivity, we find subject-centric concepts creeping back (though in scientific dress). It's as if the metaphoric pendulum swings: we went from spirit (ancient) to matter (modern) and now toward information (postmodern?), which has elements of both – it's abstract like spirit yet quantitative like matter.

The looming arrival of **Artificial General Intelligence (AGI)** and further quantum breakthroughs will likely spur fervent debates: Are we machines or something more? Is reality a simulation and does it matter? Could AI be "alive" or "conscious"? These discussions will reshape ethics, religion, and our sense of purpose. For instance, if one adopts the view that *we live in a simulation*, traditional religious narratives might be reinterpreted (perhaps "the simulator" is analogous to God, etc.), or if one believes *the universe is a learning AI*, one might ascribe purpose to evolution and history (the universe learning about itself, perhaps).

We should also be aware of the socio-cultural context: typically, metaphysical metaphors also serve to *justify or explain the social order* in their time. The clockwork universe of Newton accompanied the Enlightenment's clockwork-like faith in rational institutions and predictable progress. The information/network view today parallels globalization and the internet weaving everyone together, and perhaps provides a backdrop for seeing consciousness as distributed or collective. In the AI era, if we say "life is an algorithm," that might influence how we treat living beings (maybe making us see them as optimizable or replaceable), which

raises ethical considerations. Conversely, if the narrative becomes "the universe is conscious/information," that might resacralize our view of nature (closer to animism or pantheism in effect, fostering respect for all existence as part of one mind). So these metaphors are not just esoteric – they have real impact on values and behaviors.

In conclusion, philosophers leaning on current technology to explain reality is a feature, not a bug, of intellectual progress. Each metaphor reveals aspects of truth even as it oversimplifies others. The clay metaphor captured the malleability of life but missed the dynamism; the clock metaphor captured regularity but missed complexity; the computer metaphor captures logic but perhaps misses emotions or qualia. The next metaphors will have their own strengths and blind spots. The ultimate reality, if such a thing can be spoken of, likely transcends any single human-made comparison. As our tools evolve, our metaphors will asymptotically approach that reality, each one a bit more refined.

Thus, the **deep research takeaway** is this: *always be aware of how the spirit of the times influences "ultimate explanations."* What we take as literal today might be seen as metaphor tomorrow. By studying the lineage of ideas – clay to clock to code – we not only enrich our understanding of each era, but we also prepare ourselves to critically evaluate the coming claims of AI-age philosophy. We can appreciate the insights offered (e.g., that information underlies physical form) while avoiding the hubris of declaring all past thought null. Instead, we integrate, we contextualize.

We can already "see it coming," as the user says, that some will proclaim **"the world is *really* just an algorithm / language / quantum code,"** dismissing previous views as naïve. When we hear that, we should nod, recalling that indeed others once said "the world is *really* just a machine" or "just the play of the four elements" and so on. And we should recall how each of those statements was simultaneously insightful and incomplete.

By being conscious of this pattern, we stand a better chance of using new metaphors wisely without becoming their unwitting prisoners. The technologies of breath, pottery, weaving, music, mechanics, thermodynamics, computation, and AI have all expanded our grasp of nature. The next ones – be it quantum computing or something unforeseeable – will do the same. Each time, we rewrite the story of "what the world is made of" and "how it really works," and each time, the story edges closer to encompassing all previous chapters in a grander narrative.

Sources:

- Ancient creation myths of life from clay across cultures [7], showing early use of craft metaphors in cosmology.
- Concept of breath/spirit (pneuma, ruach) as life's essence in ancient thought [65] [66].
- Weaving metaphor in Egyptian and other traditions for describing reality's interconnectedness [11] [15].
- Pythagorean "music of the spheres" illustrating the musical model of cosmic order [20].
- Descartes' comparison of living functions to clockwork, exemplifying the 17th-century mechanical philosophy [27].
- Laplace's vision of a deterministic clockwork universe, a hallmark of mechanistic determinism [31].
- Wikipedia on heat death and entropy, reflecting the 19th-century thermodynamic worldview shift [32].

- Wheeler's "It from Bit" doctrine, encapsulating the late 20th-century pivot to an information-based reality [39] [1].
- Tegmark's assertion that the universe *is* mathematics, a modern extreme of the information/metaphysical trend [51].
- Penrose & Hameroff's argument that the brain is a quantum computer, heralding possible new quantum metaphors for mind [2].
- The holographic principle's suggestion that our universe might be like a 2D/3D hologram, an information-centric physics breakthrough [45].
- Bostrom's simulation argument framing the contemporary idea that reality could be a computer simulation [50].
- Emergent abilities in LLMs, indicating how AI learns complex tasks from language alone [53] and hinting at language as an independent generative structure.

All these illustrate the close coupling between *the stories we tell about the world* and *the tools we have at hand*. It has been a rich co-evolution – and it continues, with us as participants and witnesses to the next turn of the wheel of metaphors.

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