Rudrakṣetrajñavargaḥ samudayati yato yatra viśrāntimṛcched-
yattattvaṁyasya viśvaṁsphuritamayamiyadyanmayaṁviśvametat|
Svācchandyānandavṃdocchaladamṛtamayānuttaraspandatattvaṁ
caitanyaṁśāṅkaraṁtajjayati yadakhilaṁdvaitabhāsādvayātma||

From the smallest thing of the universe (*anuttara*) the eternal primordial rhythm is born (*spanda*) and it fills the entire universe with that; that rhythm dances as the creator and the destroyer, it makes the self and destroys the self, it is born from what it makes.

1 Philosophical Transformation Essential to Reverse Engineer Consciousness

1.1 HOW DO WE DIFFER FROM THE EXISTING WORLDVIEW?

In our wonderful brain, we live in the past, present, and future at the same time. We are a creature of time, operate in time, and evolve with time. For more than 15 years, we have compiled the investigation of periodic vibrations or clocks deep inside a neuron, in the single proteins, to map the neuroscience of time. We have investigated the wide varieties of studies on complex nanomachines to see the dance and simultaneously listen to the music of proteins to learn how its atomic groups keep time as we live. We have compiled protein-inspired complex organic nanomachines to realize the creation of clocks that started life on this planet 4.5 billion years back. We feel that in the century-old adventure to learn "how do I exist," we missed a key aspect of our brain. Our consciousness emerges in the femtosecond (10^{-15} s) clocks of a few atoms in the proteins to the nanosecond clocks of the protein complexes to the millisecond clocks of neurons in the 100-years clock (10^{11} s) that regenerates our heart cells. Conscious experience has a time-bandwidth of 10^{26} orders,—a brain is more than a black hole or a time machine (Buonomano, 2017). All the clocks at all levels simulate the past, present, and future; all interact with operating in real time. Unless we unveil how nature assembles the clocks following a metric that has no boundary, no assumption, and no rules to build, we cannot understand the physics of time—cannot explain how materials break symmetry to keep time. So, we made a journey to demystify the mathematics and the physics of time to eventually learn how an organic reaction could synthesis "time" in the architecture of clocks. In the universe of elementary particles, the knots and loops of energy transmission paths follow the symmetry of primes (Broadhurst and Kreimer, 1995). The use of prime numbers shocks us. Does the universe write its code using primes? George Orwell said, "Who controls the past controls the future. Who controls the present controls the past." We envision a map of the human brain as a 3D architecture of clocks, driven by a metric of primes that is the most fundamental pattern of the universe with zero assumptions. We foresee a mother's womb like futuristic incubator synthesizing an organic artificial brain, namely, a nanobrain.

> I insist upon the view that "all is waves."
>
> **—Schrödinger letter to John Lighton Synge (9 November 1959), as quoted by Walter Moore in *Schrödinger: Life and Thought* (1989).**

Ten fundamental transformations in the existing scientific culture are outlined in Figure 1.1. We describe 10 points one by one.

The current culture's model of learning to learn science is to ask a series of questions, whose answers would be "yes" or "no" (i.e., a bit). The philosophical argument of the universe as "it from bit" (Wheeler, 1990) suggests that one could melt every single piece of information, from the smallest to the largest, into a "bit" stream. We melt matters, forces, identities, and invariants and rebuild them as a one-dimensional thread. Different questioners ask different questions about the same event, based on their own varied perceptions. It is a scientific practice to design and build machines that ask questions in a similar fashion, and then all the reviewers get the same result. Consensus on the right question is political, thus the majority paints a picture of nature (Kuhn, 1962). Perception has led to the 12 versions of quantum mechanics; the wildest dreams of the string universe have reduced 60 dimensions of the universe

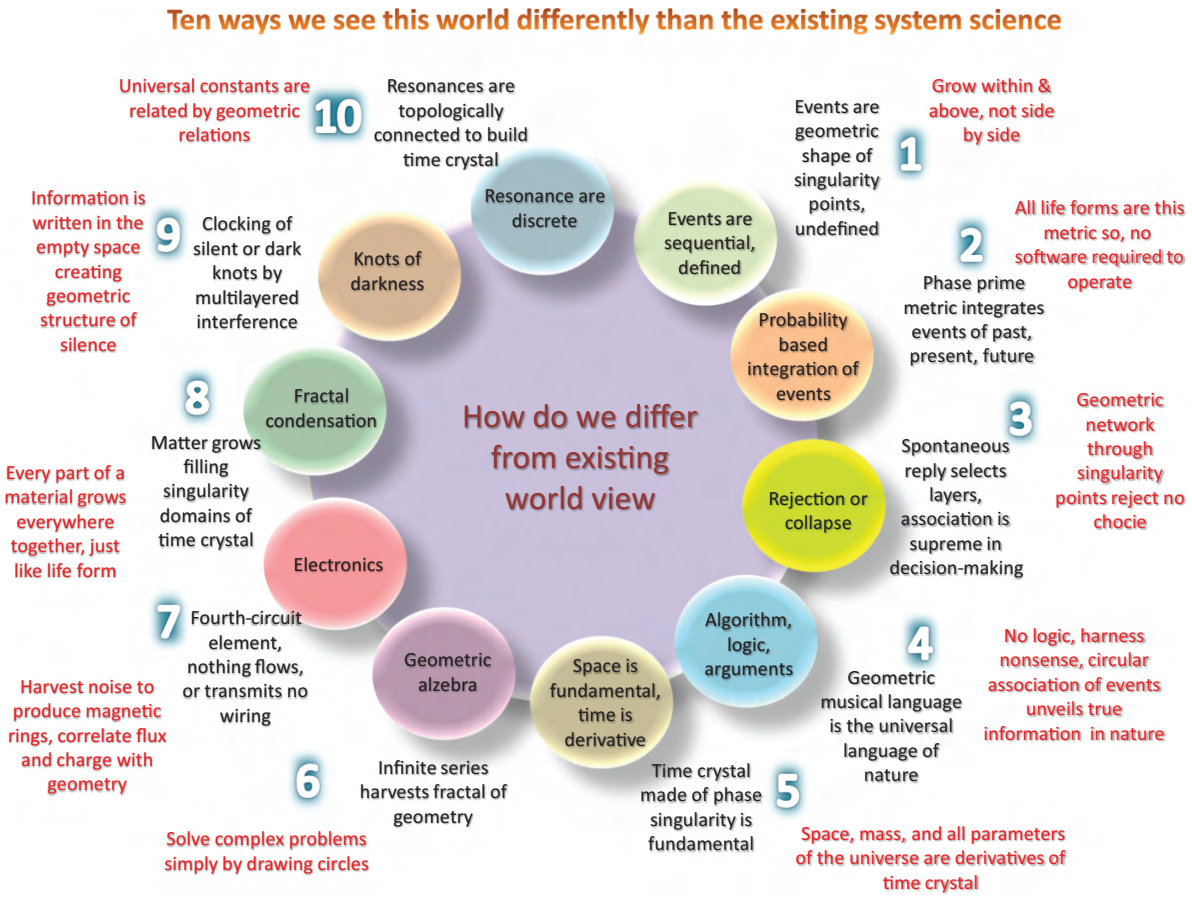

FIGURE 1.1 Ten basic concepts where computing based on fractal of primes diverts from the existing practices of scientific studies.

to just 10. Theories on how the brain works, what is consciousness, and multiverses are countless. If a "bit" or qubit brings a bias, to avoid it, the map that links the events is sensed from nature, which was otherwise ignored, and that map is converted into a geometric shape. An event's key factors are set at the corners of that geometric shape, since each key factor is linked to many events: new events grow as a new geometric shape inside those corner points. It's a tectonic shift from the sequential worldview: now events are growing within and above a corner point that is a singularity, not side-by-side bonded by a human bias called an algorithm.

The second point of Figure 1.1 suggests that if the events around us are geometric, then the sides of the shapes could be a ratio of integers and possibly represented as the nearest ratio of primes. Since the primes create the integers, when a few geometric shapes arrange to create an astronomically large number of structures of the universe, that could be viewed as an effort to create infinite series of integers from a few primes. The ratio of primes depicts the symmetry of a structure; thus, the natural pattern of primes would link the symmetries of all possible events around us. Most interestingly, life forms, which are an assembly of events at various spatial and time scales from molecules to cells, could have a common pattern of primes. A name is given here to this pattern: phase prime metric (PPM). Linking it with natural events would have many aspects (Harris and Subbarao, 1991; Warlimont, 1993; Dickau, 1999; Richmond and Knopfmacher, 1995).

The third point of Figure 1.1 is about the proactive roles of senses. The old school suggests to reject all choices but one, to set a logic. A system could itself be a seeker, not a dumb receiver; then we do not debate about the quantum collapse or rejection: it's the one whom we want to select who is seeking *us*. Then, all the choices contribute, since the choices too have geometric shapes. They reshape: the corners of shape, made of singularity points, shift but hardly disappear. Imagine a thread passing through the singularity points: by finding the corners of a geometric shape perpetually, braiding of many such threads is how events unfold around us.

The fourth point in Figure 1.1 is a quest to find the basic language of nature, not imposing the human emotion-built logic as an algorithm to fit a few observations. Since a few primes, around 15, could generate 99.99% of all integers in the universe, if one finds a few geometric shapes intimately related to the first 15 primes:

(2,3,5,7,11,13,17,19,23,29,31,37,41,43,47)

Then a new language of geometric shapes could replicate 99.99% events happening around us in nature. That language is the geometric musical language, or GML (Agrawal, 2016b).

The musical word refers to multiple interconnected clocks; when the system points move along circular paths, sonification leads to beautiful music. Fifteen primes are the 15 letters of GML, just like the English language has 26 letters. Cellular automaton promised to recreate the universe, starting from simple patterns (Wolfram, 2002). Here, the natural selection of automaton rules by a pattern of primes would create an astronomically large catalog of intelligent decision-making.

The fifth point of Figure 1.1 is the existing belief that space is fundamental, and the time is its derivative (Girelli, 2009). If we ask ourselves, "What does the geometric universe look like?" we learn that it is a 3D geometric shape, and each of its corners holds another geometric shape inside. Since each geometric shape is encircled by a clock connecting the corners, one could forget the shape and imagine a 3D architecture of clocks, that is, a time crystal, which could either be classical (Winfree, 1977) or quantum (Shapere and Wilczek, 2012). Thorough and wide-ranging documentation is presented in this book to help us rewrite a few physical phenomena (e.g., resonance and quantum mechanics, including basic math like addition and subtraction) in terms of nested circles or clocks (Chapter 4).

The sixth point of Figure 1.1 is developing a mathematical tool to analyze the world within and above. When a quantum has one imaginary world of time,—if we, say, imagine a mathematical universe with 12 imaginary worlds, one inside another, for every physics principle—that's trivial. For 200 years, 4 and 7 imaginary worlds have been studied as quaternions and octonions (Cayley, 1845; Furey, 2018), but here the number of imaginary worlds would vary from 1 to 12, as groups of imaginary worlds interact. One imaginary world in quantum has made humanity crazy for over a century: imagine what 12 worlds would do! In that new paradigm, somewhere an imaginary world at layer 3 could interact with an element at layer 10 and affect some element at layer 1. The real world has no clue about this phenomenon. Such undetected manipulations increase manifold when we imagine 12 imaginary worlds: a dodecanion. Then there is no journey across the imaginary worlds like $3 \rightarrow 10 \rightarrow 1$, but the loops like $3 \rightarrow 10 \rightarrow 1 \rightarrow 5 \rightarrow 9 \rightarrow 3$, which we call a manifold pathway. A new type of geometric algebra is to be born.

The seventh point of Figure 1.1 is to replace electronics with a new kind of information-processing device where a part of the device is made transparent that acts like gates. Then by storing charge in different patterns at different layers, some opaque to signals, some transparent, magnetic part of the light is harvested and that magnetic light is morphed into clocking vortices like artificial atoms and molecules. Imagine that different planes in a device are storing charges in different patterns and vibrating like clocks, and those interactive clocks are being read and printed in the cluster of magnetic vortex atoms. No flow of electrons: the device acts like soft mud. Artists with an electromagnetic source could sculpt many geometric shapes by storing charge; the pattern of charges would build a network of clocking loops of the pure magnetic field as a geometric shape. Time crystals of interactive planes holding the pattern of charges and the time crystal of magnetic atoms are similar. The flux-charge device is called Hinductor, since Chua asked us not to call it a memristor (Chua, 1971) and to give it a new name.

The eighth point of Figure 1.1 is about building new materials. Typically condensation, where a lot of energy levels come together, brings materials along with it, often using self-similar reaction kinetics (Kopelman, 1988) that could be programmed (Ghosh et al., 2016b). The code is written in a seed material in terms of primes: the ratio of resonance frequencies is a set of primes. Then, in a cavity, the seed material expands like prime numbers by similar self-assembling materials to eventually build integers. In doing so, different parts of the structure act like seeds and start building more cavities, clocks, and singularities, and those singularity points would connect, and every part of the structure would become a seed. When singularity domains of time crystals are filled all over a material, every part grows and decays simultaneously; such a phenomenon is termed here as fractal condensation (Chapter 9), which is ultrafast (Sahu, 2014).

The ninth point of Figure 1.1 is about multilayer interference, where the product wave functions of one interference are used as the ingredients for the next interference. For more than 35 years (Nye, 1983), in the 3D space, an electric or magnetic part of the light was neutralized. One could store and process information in an empty space, using strings of darkness ($E = 0$ or $B = 0$), which could never be used as particles. Here we compile research where the dark strings are produced in the vicinity of a material. What was being done earlier in open space is now to be done at the light-matter interface. Plenty of opportunities open if those strings are somehow reshaped as usable vortex-like atoms, then we can use them like matter and build unprecedented engineering. Starting from the atomic scale to the ultimate architecture, there are multilayered interferences: multilayer beating and multilayer condensation of spin-like clocks.

The tenth point of Figure 1.1 is about the inherent links between different kinds of forces and associated resonances operating in widely varied materials. If the resonance frequencies differ by several orders of magnitude, there are limiting velocities of carriers restricted by a given material. There cannot be an ideal material that allows all types of carriers to flow freely at all allowed speeds (i.e., fit for all time zones). If the events happening in nature integrate within and above in different time scales, then each layer acquires multiple fundamental constants, like the velocity of light, and exclusive action (one example of action is the Plank's constant h), which gives birth to distinct imaginary worlds. Thus, a singular imaginary world in quantum is known to be found at the atomic scale, but here, since all imaginary worlds operate by the synthesis of an unprecedented carrier called magnetic vortex atoms, they follow a new mechanics (Chapter 4).

If everything is made of clocks, the past, present, and future are locations on a large time crystal architecture. A time crystal looks so different from different directions that if one reads it from 360° directions, using a probe time crystal, it appears very different. The sonification of a time crystal that represents a decision made by the brain resembles music, so maybe it also signifies life. The free will may originate from a composition of PPMs, whose symmetries are written in multinions; that is, one, three, seven, or eleven imaginary world

tensors. The brain's time crystal could well be a guest of its environment's time crystal, which possibly is a tiny guest in the universe's time crystal. The inherent music of thoughts modifies the biological elements to fill in the gaps of this chain, filling the universal mathematical pattern of free will. Therefore, expanding the pattern of prime to attain 15 prime symmetries more and more intricately is genuinely living and evolving in this universe.

1.2 TEN RESEARCH FIELDS THAT WE COVER HERE

In the last century, quantum concepts have transformed three major dimensions in our worldview. At the smaller scale, the distribution of energy is not continuous; the energy parcels into discrete, isolated packets. Second, the smallest entity that makes everything is a field like a rapidly changing jelly. Third, far distant particles or energy packets could reside in a single time coordinate. Occupying time is as pure as occupying space. Using the telescope and radar, we know what our universe looks like physically. One day, we would find what the universe looks like temporally; the journey begins here with a catalog of the clocks in the brain–body network to reverse engineer consciousness (Figure 7.15). The journey to visualize the architecture of time in life forms started in the 1970s as time crystals (Winfree, 1980, 1987). The culture to map the universe as a composition of time crystals would unfold only when new kind of sensor that acquires 11D data in the time crystal format would begin. A vision of a fractal-like universe, with nested spheres ad infinitum, was envisaged by the Swedish astronomer C. Charlier (1862–1934) and Ray Tomes (Tomes, 1990) from New Zealand, who dreamt a pattern of primes to govern all symmetries and events of the universe. Those concepts are fused here to reject and replace the old belief that a supercomputer's parallelism is like the brain's parallelism (Nowakowski, 2018). We cover 10 fundamental topics in this book to eventually replace the existing culture of 1D (dimensional data) engineering to acquire 11D information as time crystals—bit by bit as outlined in Figure 1.2. Note that 11D has been observed by some groups as a physical structure (Reimann et al., 2017) in the brain as basic geometric shapes. However, here the 11D data with geometric shapes are in the frequency domain or time domain; using physical perception, those shapes cannot be found. Thus, Reimann et al.'s proposal suggests that to store a triangle—a wire-like a triangle, in this case—vortices or spirals are the only shape of the materials; matter and vibrational information are not similar.

Here are the 10 topics outlined in Figure 1.2 and these discussions will be covered in the next eight chapters.

1. **Fractal Information Theory (FIT):** Information in the brain or the universe is not a bit, but a time crystal, which has singularity or holes to glue with other crystals: a Bloch sphere with a hole is not a Bloch sphere. The basic concept of linguistics, how humans frame an event, is embedded in the time crystal, and

FIGURE 1.2 Ten original research fields were built for the development of an artificial brain.

that basis is held irrespective of dimensions of data or the number of imaginary worlds addressed. Who did it? At which condition? What did it do? How did it do it? (Reddy et al., 2018). When a multidimensional map of key factors that defines an event is captured from nature, it cannot be linearized even in an infinite Turing tape (Hamkins, 2000).

2. **Fractal Mechanics (FM):** Quantum mechanics deals with only one imaginary world, if one requires plenty of interactive imaginary worlds, say 11 imaginary worlds for a dodecanion, then **fractal mechanics** (FM) is a term coined to incorporate all works where the wave functions are nested in different imaginary worlds at the same time. Every single phenomenon that has a classical and quantum version would also have an FM version. Since the interaction among the imaginary worlds builds a hierarchy of groups, a distinct mechanics is required. Condensation, beating, interference, and harmonic oscillation all originate from fractal resonance, where the symmetry of frequency distribution emitted from singularity points of a time crystal evolves differently but simultaneously in various worlds, seeing one another and changing simultaneously. Quantum discussed at a small scale all are discrete and there is no connection among them; FM tells us the connection is there, but many actions guided by their PPMs create an invisible cloud, and "silence is the language of god, all else is poor translation (Rumi)."
3. **Language for operating a new kind of time crystal:** In the last half of the twentieth century, the research on time crystals and phase singularity was limited to studying reactions to external perturbation. The spiral- and vortex-shaped devices generate time crystals where the phase singularity is embedded in the device geometry, so it is fundamental, not a reaction. This is a fundamental difference and helps one to use singularity-induced bursts to develop engineering of self-assembly, information processing, noise harvesting, and so on. By blinking the singularity or holes in the phase space of the spirals, the **geometric musical language (GML)** operates, where all input information is converted into a 3D geometric shape (event = quaternion time crystal). In this language, information is an assembly of the geometric shapes, whose corners are singularity points: a system point rotates in a loop, touching the singularity points or the holes, which make a burst (number of corners = number of bings). Silences between the bings in a loop count the ratio of primes, that is, the symmetry of the geometric shape. In the pattern of divisors of integers, a PPM links all symmetries of the universe to evolve geometric shapes.
4. **Phase prime metric (PPM):** Often it is believed that a pattern of primes would reveal the most fundamental rules that govern the universe; since the primes generate integers, the gap is filled by a new prime and hence the pattern of primes continuously evolves ad infinitum. PPM holds this self-evolving pattern as the key skeleton. PPM does not look into the pattern of primes except when the primes are arranged to build integers, which themselves follow similar rules primes follow to create integers or fractal-like features therein. This had remained unexplored in mathematics. PPM is, therefore, a collection of several such compositional rules hidden in the integers, waiting to be explored from the beginning of counting. The metric is physically realized by, tuning the topology of specially designed helices and vortices namely inductor H and thus editing its geometric phase (Lauber et al., 1994; Pistolesi and Manini, 2000; Pechal et al., 2012; Lee et al., 2011; Joshi and Xiao, 2006). The geometric phase of H is peculiar: it acquires the singularity state at certain conditions, and the singularity is the corner point of a geometric shape written in the time crystal of H. An event in nature repeats until a set of symmetry representing the event breaks; if the events are nested within and above, this is an infinite series. An event for us is a geometric shape, say a triangle, represented by 3. Using 3 alone, we can create an infinite series, multiple of 3; similarly, 12 events could generate infinite topologies when $2 \times 2 \times 3$, $2 \times 3 \times 2$, and $3 \times 2 \times 2$ arrangement would turn integers active anywhere in PPM, and teardrops of events are triggered (Figure 3.4). Thus, the reflection principle has received a major overhaul here. The principal principle (Lewis, 1980) suggests that we should choose probability such that even in an absolutely random scenario, an event really happens. If it does not, the probability is useless. Using the pattern of primes, we avoid the necessity of probability; PPM is a compiled Dutch book. The ordered factor of all possible events is compiled to make the prime metric a coherent system (Ramsey, 1926; de Finetti, 1937; Shimony, 1955; Kemeny, 1955; Lehman, 1955). Any event, when it takes a clocking geometric shape, we can then, using a PPM, extrapolate its past and future.
5. **A time crystal model of a human brain:** Painstakingly almost every single component of the brain was mapped, in the software and in the hardware, by using tiny dielectric and cavity resonators. By solving Maxwell's equations, the electromagnetic resonance of the components was measured and experimentally verified. The nested clocks were collected from the dispersed database of reported rhythms for 80 years. The first comprehensive catalog of 534 classes of brain rhythms was reverse engineered using copper wires in a 1:1 million ratio in the brain, and 20 conscious expressions were replicated for the humanoid-like response of the avatar (Chapter 9).
6. **Continued fraction geometric algebra (CFGA):** Geometric algebra accounts of the efforts are made to link integers using a geometric shape (Hestenes,

1986). The algebra for a fixed imaginary number already exists: for example, quaternion with three imaginary worlds, octonion with seven imaginary worlds, which were related to Clifford algebra, Lie algebra, and so on. Here we account for a massive transition of octonion to dodecanion, or 11 imaginary worlds. One has to invent the tensor for dodecanions, which is the most primitive tensor for the algebra of multinions, that is, a variable number of imaginary worlds. The mathematical calculation is done by **continued fraction geometric algebra (CFGA)**, which is a new type of mathematics where one draws circles and complex mathematical operations are carried out from the convergence of drawn circles. For the artificial brain, a new operator has been proposed that is 10 steps of geometric operations one after another, solving all major mathematical processes required to regenerate 15 prime symmetries, in case a time crystal acquires an asymmetry (a problem).

7. **Fourth-circuit element: Hinductor (H):** Three circuit elements are a resistor, capacitor, and inductor, and the fourth one that should link stored charge and flux is missing (Chua, 1971). It is not about a memristor, which wrongly claimed current, or voltage device, as a fourth-circuit element. Instead the Hinductor is a real circuit element that generates magnetic vortices as a function of the stored charge when monochromatic light falls on it. It is a metamaterial that cloaks quantum mechanically, which helps in making a part of the device invisible to others. Cloaking enables building circuits without wiring. Quantum cloaking is invisibility for the matter wave. H builds a universal time crystal (UTC), harvesting noise by exploring unique concentric spiral geometries. No electron transmits, only the phase transmits: it is not electronics, but magnonics.
8. **Neuroscience of filaments:** Neurons and cells are densely packed with protein-made, nanowire-like filaments. These nanowires have only one job, providing strength to the cell like a skeleton. However, now the coaxial probe experiments have shown that the filaments deep inside the neural branches check the potential difference across the junctions by sending and receiving electromagnetic signals (Ghosh et al., 2016a, 2016b; Agrawal et al., 2016a). The paradigm shift from the neuron skin–only neuroscience opens the door to resolve several more mysteries of neuroscience, as well as links the events happening in the brain in the seconds time scale to the femtoseconds oscillations of functional groups.
9. **Fractal reaction kinetics and fractal condensation** are, respectively, a new kind of multi-kinetic synthesis and a new class of condensation where multiple reaction centers activate at once. When a baby grows from the embryo, it is a multifractal architecture growth, where the system builds every part simultaneously. Using fractal reaction kinetics, one could run multiple reactions in a single beaker, and using fractal condensation, one could use the principles of cavity resonator to create a 3D pattern of fields in a closed space where the matters would arrive and self-assemble, all parts of a massive architecture at once. Since the artificial brain under exploration in this book requires self-assembly of spirals within and above in various layers (at least 12 times for a dodecanion), fractal reaction kinetics and fractal condensation are key synthetic tools.
10. **Brain jelly to the development of a humanoid avatar: The first primitive conscious machine**! A brain jelly is a material where one could write environment-acquired information as a time crystal of prime numbers and let it evolve into complex architectures following the pattern of primes. A time crystal analyzer (TCA) converts any sensory information into a 3D pattern of geometric shapes, which converts into a time crystal of primes, feeds the time crystal to the organic jelly, and reads the output pattern of magnetic vortices and optical vortices into a time crystal of primes.

    Brain jelly is not an already synthesized organic supramolecule that computes. Before every decision-making, the solution is melted, the synthesis begins from the precursor molecules in a tube with the thermal gradient, and jelly consumes thermal and chemical energy—but only when an input time crystal is pumped. Then the system starts building spirals and vortices, following, most interestingly, a Hasse diagram of primes, which is thermodynamically most favorable. The synthesis does not stop building the material analog of an input time crystal. It is the reason the brain jelly builds a typical pattern of primes as a new metric, for every new input. As the jelly grows, by shining a monochromatic laser light, the evolution of input time crystal could be read by projecting the light-produced magnetic vortices on a magnetic film. Brain jelly reads the dynamics of a big data, splits it in all possible compositions ($30 = 2 \times 3 \times 5\ldots$), and freezes the evolution of dynamics as a supramolecular material whose electrical, mechanical, and magnetic vibration generates a time crystal in the oscillating patterns of the stored charge. We read that in the crystal made of atoms of magnetic light.

One material cannot be an ideal brain jelly, which is very efficient in generating elementary structures of all 15 primes. Some precursor to jelly is good for some primes. So, inspired by a human brain, mimicking the cortical columns, a large number of distinct precursors-based solutions are used in a single unit. Consequently, the helical gels are taken in 19 columns, each column with seven distinct layers. In other words, more than $19 \times 7 = 133$ types of helical supramolecular structures are required to replicate one basic unit of Brodmann's functional region, out of 47 in the cortex; 2D sheets of hexagonal close packing (HCP) of cortical columns are used as folded

2D sheets (Hinductor class III, H3) at plenty of places to build brain components such as ganglions, the hippocampus, and the cerebellum layers' nuclei (Figures 7.11c and 9.3c). The 2D sheet H3 is the final product required to build a self-operating humanoid avatar.

1.3 THE UNIVERSE WITHIN AND ABOVE NOT SIDE BY SIDE

Figure 1.3a describes how three events expand in the existing paradigm of quantum or classical worldview and then the fractal worldview. In the first worldview, expansion of an event means adding more subevents linearly; however, in the fractal overview it's all about expansion of events within and above. One should note that when events are geometric, the ratio of sides is represented as integers and then converted to the ratio of primes.

The evolution of the culture of doing science: An artificial brain driven by a pattern of primes would be reductionist, since it assumes that the pattern of primes that includes all possible symmetries in the universe is fundamental, from which all other theories of science could be derived. Its theory of knowledge or epistemology is that the pattern of prime numbers is an architecture mapping how all possible symmetries in the universe will be linked to one another. The pattern of primes, converted into a temple-like geometric structure, the PPM (Figure 3.2d), which is independent of the human mind and is thus bias-free (Courtland, 2018), supports the scientific culture of realism. In the beginning, the practice of science was to derive a general law or principle from the observation of statistically significant events. Then came the idea of verifying a conclusion by experiment, namely, inductive logic. Then came the falsification proposal, where science is about trying to falsify a theory rather than trying to gather evidence in its favor (Popper, 2002; Lakatos, 1970). Here, the geometric artificial brain contributes to the idea of logical positivism, where the proper use of language in constructing an argument would solve everything. Instead of human language, we would explore a new language called geometric musical language (GML) to do the same.

> God knows I am no friend of probability theory; I had hated it from the first moment when our dear friend Max Born gave it birth.
>
> **—Schrödinger to Einstein (13 June 1946)**

Fifty years of Bayesian reflection principle, exchangeability, and principal principle: Futility of bias-free learning: Bayes theorem tells us how to find the probability of an event happening in a given set of choices. No one questions the formulation, but the number of variables and their interactions are subject to human imagination (Howson and Urbach, 2005). It is true that the target concept or bias has to be included within the hypothesis, else training that links input and output would fail (Mitchell, 1980; Schaffer, 1994; Wolpert, 1996). So, if we have not experienced the future, we do not have any valid reason to consider it as truth (Hume, 2000 [1739–40]). Bayes' theorem with three added precautions is believed to restrict human imagination, making scientific practice (Nola and Sankey, 2007) little better than pure falsification. The weakness of Bayesian culture is that it assigns a prior probability to a novel hypothesis, while it should be derived from no law or assumption, as argued by Wheeler (1980). A free human will governs the statistics of observation. Hence the derived probability varies with different minds. Three restrictions to constrain the role of free will—by exchangeability, the reflection principle, and the principal principle—are not enough. In the geometric artificial brain, we see that random events unfolding in nature are linked by symmetry, following a typical pattern of primes that we conceived, namely, the PPM. Thus, exchangeability (de Finetti, 1937), which suggests treating symmetric events symmetrically, is honored by the PPM. The reflection principle (van Fraassen, 1984, 1995) suggests that if the conditions remain the same, the probability will not change with time. It is a primitive condition. In the real world, the conditions hardly remain the same.

Bayesian approach has to go beyond Popper's falsification: Where H = hypothesis, D = data, and B = background information, Bayes' theorem tells us that P(H|DB) = P(H|B) P(D|HB)/P(D|B). P(D|B) is independent of any hypothesis, so maybe ignored when comparing hypotheses. Enumerative induction seeks to maximize P(H|DB) directly, Popper's falsification generalizes to maximizing P(D|HB), while the aim of abduction (also known as inference to the best explanation) is to maximize P(H|B)P(D|HB) where D consists of facts.

Redefining the intelligence of artificial brain: Rejecting Bayesian protocol to do a scientific study and replacing it with the PPM and GML redefine the definition of intelligence. Until now, the most accepted definition of intelligence was the ability to assign a realistic prior probability to a novel hypothesis (Carroll, 1993). Now, PPM derives a hypothesis from reading natural events using GML. The intelligence of a PPM-GML engine is the number of prime symmetries configured in its hardware; an asymmetry is detected as a problem, and the recipe for regaining symmetry is the solution. The length of PPM is infinite since the number of primes is infinite; 15 primes do not reject all other primes, and holding 99.99% neighbors of the primes also means holding the primes in some other way.

Spirals and vortices ask about the universe: Spirals and vortices are everywhere from proteins to the galaxies. "The double helix, the four-base codon alphabet and the triplet genetic code for amino acids, any particular gene for a protein in a particular organism—all are the frozen accidents of evolutionary history" (Hogan, 2004). Carbon, a key to life, forms by a three-alpha process. Two of them are very unstable (10^{-16} sec; 8Be, 4He), but they commonly trigger a three-alpha reaction that is very slow; that resonance peak was found by Livio (2003). He observed in the experiment with the tubulin protein that, when triggered with a suitable frequency signal, the proteins assembled rapidly into the microtubule nanowire that has regulated cell life for 4 billion years (Sahu, 2014).

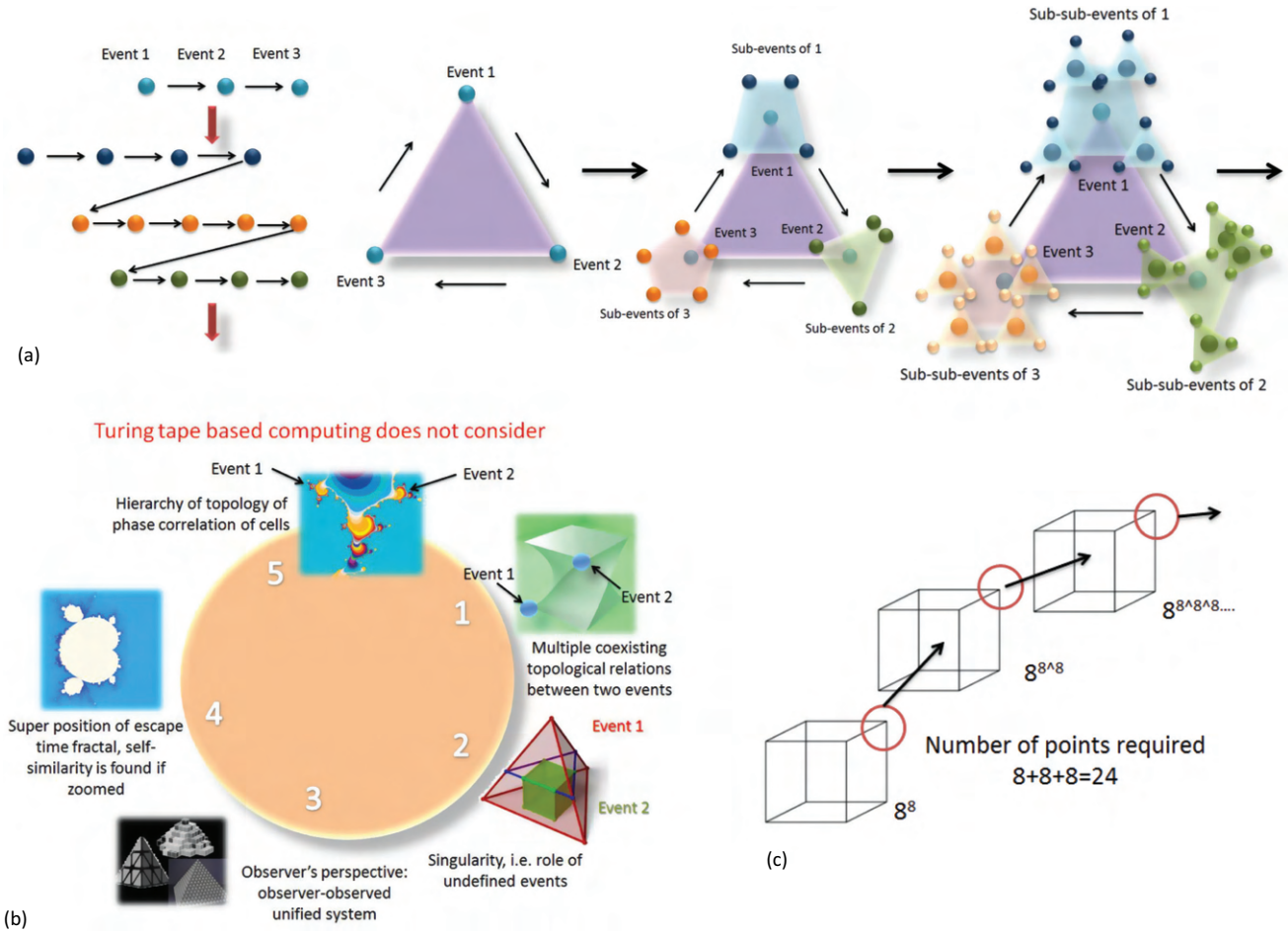

FIGURE 1.3 (a) The Turing machine–based concept rules the world currently, where dots depict events, like "eating food," "dancing," etc. The schematic on the left shows the sequential way of looking into the events. In the fractal machine proposal, where events are connected by a phase change that forms a geometric shape. Each event is grafted in a phase singularity. In three consecutive images, new geometric shapes representing a new set of events are encoded. The arrow after third triangle shows that there is no end; it's a continuous chain of events. (b) Five situations where Turing machine or sequential thoughts would collapse. (c) A singularity point in a cube holds another cube, and in three steps there are 8^{8^8} events, which is processed in the proposed nanobrain in three imaginary layers.

To explain the self-operational intelligence of viruses and primitive life forms, in the 1970s people conceived the idea of a time crystal, an assembly of clocks, where the slowest one is the host clock, holding a pair of guest clocks, running rapidly. For three decades, time crystal studies gave us the concept of meander flowers and their garden (Zykov, 1986, 1990), integrated into the time crystal for a self-operated intelligent life. This book is to bring that adventure back to life.

The research on microtubules and proteins suggest that due to a novel twist in the spiral symmetry, devices harvest noise and convert it into a pure signal (Sahu et al., 2013a, 2013b, 2014). Its fractal clock network observed in its resonance peaks resembles the primes, just like the brain (Chapter 7) and extragalactic energy bursts (Tomes, 1990).

1. Is the universe a giant machine ruled by pre-established continuum physical law? If it is running by itself, then what is driving it? Thus came the idea of a metric of symmetries governed by primes.
2. When 99.99% of the universe is empty, the debate whether space or time is fundamental is irrelevant; the prime concern is with what is the factor that brings "it" from continuum (not from "bit") and returns a continuum.

   The origin of quantum would unravel when we would sustain 11D maps of crucial factors that define an event; a revolution is needed in sensing nature, that is not possible unless we know how nature writes and integrates information. Thus, came the need for engineering singularity, a language that speaks by blinking singularities, that is, GML.
3. When an observer changes the world by observing, then did an event happen when no one saw it happening? Does a real universe exist? If everything happens by changing phase, then many nested imaginary worlds could run the universe, even when no one sees it. Imagine that looking at the moon would change it; then hardware must hold nested imaginary

worlds. Thus came the flux-charge device, a master in creating and assembling clocks in different imaginary worlds.
4. Information loss is entropy; does a metric that regulates all systems yet gains nothing, lose nothing? (Zurek, 1989).

1.3.1 What a Turing-Based Worldview Does Not Consider

Existing information theories do not consider: For over a hundred years, the foundation of information theory is based on the fundamental principle that every single event happening in nature could be explained as a sequence of the simplest event, switching between "yes" and "no." Except for a line, this principle rejects all other geometries that could connect the events, as noted in Figure 1.3b; but here, all possible connecting geometries are allowed. Moreover, each corner of a geometric shape is an independent event. Every time we enter into a corner, it is an imaginary world from outside, but the rules in that world, once we are in, are not like those of classical or quantum. The most exciting feature is that an event, in reality, could get redefined by a mere change in geometry, since the corners of multiple imaginary worlds are connected by a single thread of events. It is the second feature missing in the Turing paradigm as outlined in Figure 1.3b. There would be multiple ways to generate a closed loop between points, geometric constraints, and favoritism. The observer must be integrated as part of the information structure as outlined in point three of Figure 1.3b. All observers would impact largely on the reality we encounter. Inserting a geometry inside the corner point simultaneously adds a new set of clocks in the time crystal.

We do not have any problem with the Turing paradigm regarding the gap between the events or dots—what all we need to think is if the sequence is right. The pattern when events link within and above could have a self-similarity called an escape time fractal; that provision is missed in the Turing paradigm (point 4, Figure 1.3b). When the event is a geometric shape, the number of sides are the number of phase gaps we need to know. Here in this book, we have outlined all essential technologies required. For a cube, 8 corners hold 8 subevents, acting as 8 singularity points, but we need to know 12 phase relations: 2, 3, 4, 6, or 8 subevents could form many sub-clocks. A fractal tape would hold 8^8^8 events in a mere 8 + 8+8 clocks. What we need is the engineering of synthesizing the processors inside a singularity domain (Figure 1.3c).

Now, in the universe of artificial intelligence, human perception runs deep. The deep neural networks are multilayered, linked side by side and operated step-by-step. Parallelism is not simultaneity; the problem is the interaction between a large number of simultaneously interacting nodes with nature, which parallelism cannot address. However, time crystal network in GML grows within and above, differently multilayered; one could replace the multilayered neural network or deep learning with a time crystal. How information looks in nature or in the brain and how it is integrated is a prime query and needs to be resolved first, before we can do anything else (Figure 1.4a). Unfortunately, the brain builders of today use bits as information and imagine linking them; they consider neurons as switches and the geometry of neural networks as circuits to link devices, and that's why we finally hire human programmers to run the piece of artwork developed by spending billions of USD.

The basic philosophy of the current brain-building projects is that if one copies the neuron-like structure as is, then the properties are automatically copied. This is philosophically incomplete, as the matter is discrete, isolated, and complete, but its time crystal is not; if both are not replicated, we lose information about the "happening of an event" of the replicated structure. The structure of a time crystal holds its future dynamics: it's a seed, which forms a tree when planted in the PPM. Journeying through the singularity paths unfolds a new science.

1.4 BASIC QUESTIONS TO ANSWER: TEN POPULAR HUMAN BRAIN MODELS

The lifelike feature is missing in the existing information theories: The journey to the radical voyage toward the understanding of six key questions as outlined in Figure 1.4a, and it begins with a question: What does information look like in nature and in the geometric brain, and is it in bits? We often see 10 basic features of information in the nature around us:

1. All information is connected; there is no discrete piece of information, such as a complete defined entity.
2. There are always some contents inside any given amount of information; the very idea that there is the smallest information content is an illusion.
3. The plot and the matrix of information on the plot are the same: the information that shapes information content is the information itself.
4. Identical content can give different meaning in a different environment; at the same time, very different information often holds the same appearance; duality sustains both ways.
5. The same information is complete: at the moment, at a fraction, at the other.
6. The same information content gets the different property at the same environment, at the same time, to different observers.
7. Systems spontaneously emerge information, even when no question is asked.
8. A mirror image of information is created without changing the source, though both the source and the observer are coupled.
9. The same information takes different form at different times, thus creating a wide range of information, an endless chain of events.
10. Information is lifelike, it senses, expands, creates new life like information.

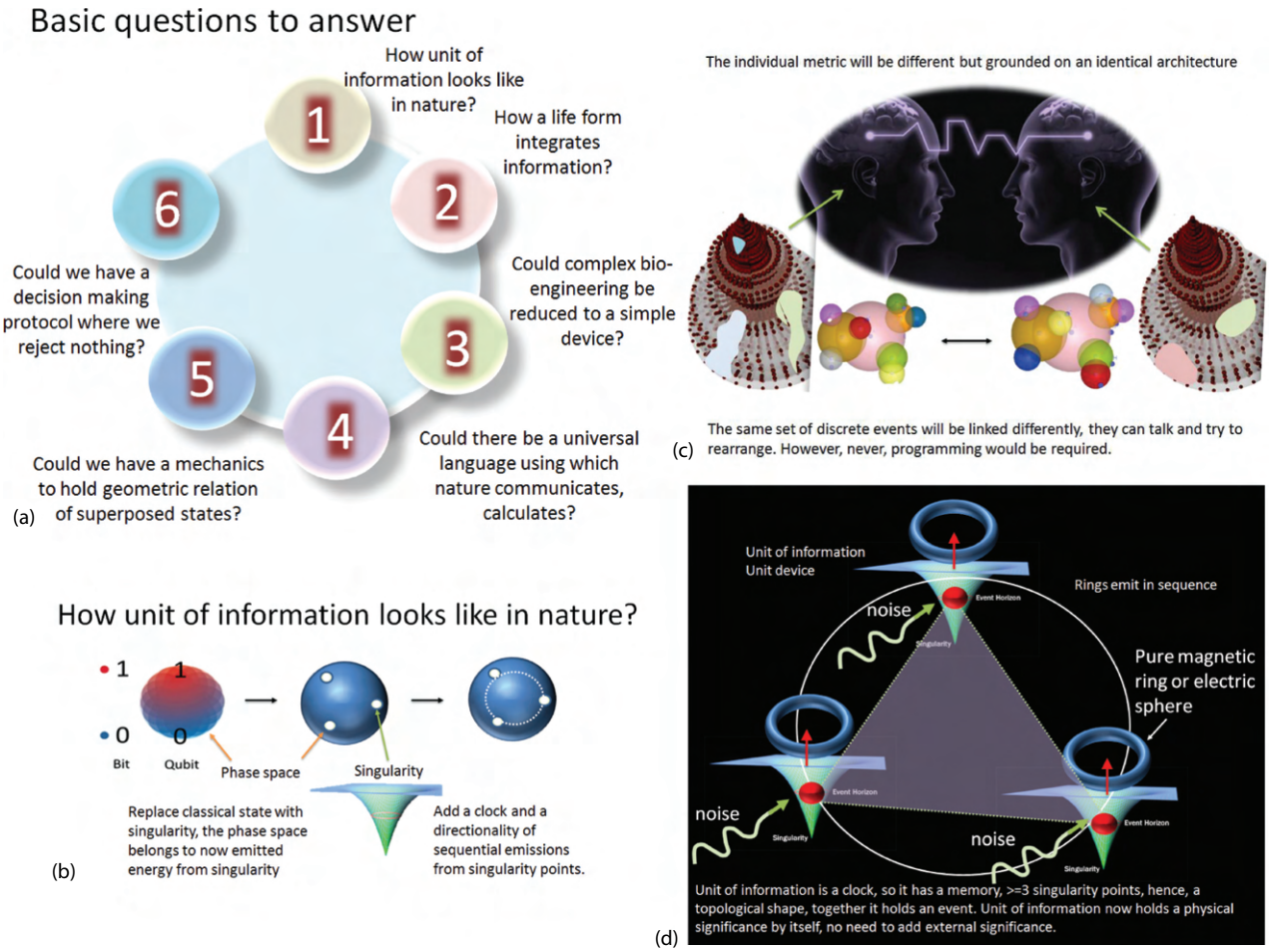

FIGURE 1.4 (a) The new kind of science requires six primary questions to ask. (b) The philosophy of representing everything in terms of bits and qubits (0 and 1, or yes and no) is changed to a composition of phase singularities where an event becomes undefined, the universe has no reality until it projects to a sensor. A new type of basic unit of information where Bloch sphere like imaginary points are there on phase sphere but no real point. (c) Communication between two brains happens here through a time crystal. Two human figures are represented using two distinct phase prime metric (PPM) architectures; PPM is a pattern of prime numbers, for each human their composition is distinct. (d) The mechanism of geometric information is written in a time crystal or architecture of clocks.

So, our journey begins by considering that the unit of information in nature is an event, even in its simplest form, it is lifelike, not isolated, connected to everything, so undefined. Information is not dead bits waiting for humans, to give it a significance. Physics at the bottom is continuous in a very different way; therein, the bit of information is not the basic entity (Hartle, 2005).

Breaking the limit of intelligence: For many, the brain is an advanced computer chip run by a chemical fuel, there is a consciousness switch in the brain, and everything happens at the neuron level. Thus, if a network is mapped in the brain accurately, making an artificial brain would be a piece of cake. Elegans never acquired life in the computer, though, neuron by neuron, circuits were intricately encoded, and we had to add an AI engine to fake its life. False memories (Loftus, 1997) and fake perceptions (Libet, 2004) are real in the geometric artificial brain. We create a living brain vis-à-vis universe models—after all, both universe and brain evolve similarly—only by symmetry. For some, the brain oscillates around a critical point (Beggs, 2012); for some it's a cavity resonator, like a flute.

1. **Boltzmann brain:** The oldest model of a self-aware entity. It suggests that a random cluster of atoms in a thermodynamic equilibrium could spontaneously assemble into an intelligent structure like a human brain (Carroll, 2017). So, the past should be a mirror image of the future (Boddy and Carroll, 2013). The time spent by a system's microstates in some region of the phase space with the same energy is proportional to the volume of this region (ergodic), i.e., that all accessible microstates or decisions are equiprobable over a long period of time. In the

geometric artificial brain, all systems are non-ergodic, with a singularity hole in them, and Maxwell's tunnel connects them, which ensures a connection en route to singularity (Palmer, 1982; Gotze, 2008).

2. **Anthropic brain and selfish biocosm:** An event does not happen if no one sees it (Copenhagen interpretation of quantum mechanics). By observing a phenomenon, a given observer changes the universe towards a conscious life (participatory anthropic principle; Wheeler, 1996): the universe is biocentric. Continuous observation changes the fundamental constants so as to let the conscious life flourish (selfish biocosm; Gardner, 2005). One could make a journey backward in time to find the ultimate cause (retrodiction), by believing in eternal inflation via 10 dimensions (Linde/Weinberg bound; Weinberg, 1999) or by adding the probabilities of all paths from the beginning until now, just like path integral or "sum over histories" (Hawking and Hertog, 2002). Here we account for a new route for a life-friendly cosmos. PPM is simply a set of curves, but when GML adds to it, the geometric constraints embedded in the metric govern the formation of fundamental constants. Consciousness to the PPM-driven artificial brain is a condition that allows coexistence of at least three editable, complete information structures of an entity. PPM allows non-computable geometric feedback from the infinite series output; its universe is consciousness friendly. Higher-level geometry hidden in the primes is consciousness-centric.
3. **Holonomic brain model** (Karl Pribram) and **black holes as baby universes:** Cosmological replication and natural selection (CNS). If the quantum is true, every time a singularity is born in the universe, they are connected. Thus, certain parameters of the baby universes are close to the parent. Fundamental constants tune so that many black holes or baby universes are born, like Darwin's natural selection (Smolin, 2004). The brain inside a brain…, an infinite network, is the outcome of a cosmic code (Pagels, 1983).
4. **Turing's "it from bit" brain:** Asking questions whose answer is yes or no, 0 or 1, it is possible to create a conscious brain and an entire universe totally as an infinite one-dimensional chain. It is possible to deduce truth by creating imaginary layers of hidden non-physical structures that reduce the choice bit by bit (deep learning). The bit is about two states; time crystal architecture is about geometry, clock speed, silence or phase, rotational direction, noise tolerance, channel pattern, imaginary layer interaction, relative amplitude, ratio of frequencies, and more—the unit of information is like a life form in itself. More interestingly, architecture of time follows a pattern of symmetries; this is a non-physical structure since it is not confined in one layer. PPM is an ideal temple, as nothing else in the universe is; life is a pattern of symmetries which senses, in the real universe, how the ideal PPM is shifted in the real universe. All PPMs, within and beyond life, autocorrect lack of symmetries generated by conflicts and thus run the universe. It is in tune with the proposal that at every moment the universe or brain tries to attain maximum computability (Gardner, 2002).
5. **Bayesian brain model:** Conditional probability of multiple events is key to decision-making and eventually consciousness (Doya, 2017; David, 2004). An extreme example of using human bias in creating information, and thus all models in this category survive through political consensus, as told by Wheeler. **Connectome-computer brain model:** Mapping and uploading an accurate map of neurons, there are several proponents of this idea. **Integrated information theory** (IIT) belongs to this category (Tononi, 2016), which again considers probability or human observation.
6. **Free energy brain model:** This proposal is now gaining momentum since higher-dimensional analysis has been gaining attention: the energy landscape shows that the brain is not a 3D structure but a 4D structure by itself (Friston, 2010). The decision comes from the 4D analysis of information dynamics.
7. **A matryoshka brain** is a hypothetical megastructure proposed by Robert Bradbury, based on the Dyson sphere, of immense computational capacity. A similar brain model is the **fractal brain model.** Multiple authors have noted that the brain is a fractal (Di Leva, 2016). Here the difference is that the brain is a fractal in the composition of primes while creating integers, not in its physical look: the group of primes is hidden in the infinite, uninteresting piles of integers that remained overlooked for centuries; no mathematician ever wondered whether $2 \times 3 \times 3 \times 3 \times 5 \times 7 \times 131$ and $2 \times 3 \times 3 \times 3 \times 5 \times 7 \times 97$ are similar, many of these compositions of primes occur infinite times when we calculate divisors of an integer, but when Reddy et al. plotted them, patterns emerged (Chapter 3). The self-similarity lies in the mathematical process, not in its appearance.
8. **Electromagnetic resonance brain:** The synchronization of spikes via resonance that carries out all the logical processes—but logic comes from human observation (Izhikevich et al., 2003) **Harmonic and dipole brain model**: flattening the brain components for harmonics-based analysis is another direction (Hurdal and Stephenson, 2009); multiple reports note, for example, that the lateral ventricles can be described in neurodevelopment by spherical harmonics. In resonance-driven development of the folding in of the cortical columns (Striegel and Hurdal, 2009), the question remained unanswered: Who resonates? Here we compiled 12 classes of

rhythms in the brain governed by 12 types of carriers that resonate in 12 temporal bands, each band configured in a triplet-of-triplet group of resonance frequencies (Figures 7.6 and 7.7).

9. **Relativistic brain model:** Dipolar oscillation, or C2 symmetry, governs resonance relativistically at the top level in the left and right brain to the bottom in the alpha-helices or DNA molecules. The relativistic effect leads to consciousness. In a highly unexpected breakthrough in this work, Nicolelis and Cicurel argued how their research replicates the central set of hypotheses in dipole neurology theory (Lanzalaco and Zia, 2009). C2 symmetry alone covers 50% of the decisions made; here we explore how that could be stretched to 99.99% (Nicolelis and Cicurel, 2015).
10. **Schrödinger brain model or quantum brain model:** The neurophysiological response of the human brain (Nobili, 1985) requires arranging the receptors, for which we need a "reference wave"-recruiting device from where information is recovered holonomic manner. The **holonomic brain model** and Schrödinger brain model require all information packed in at a local point, wherein infinite choices collapse, models vary in configuration, but never leave, in the Turing paradigm. **Quantum brain model**: Multiple proposals were made in the 1990s for quantum brain models (Beck and Eccles, 1992; Hameroff and Penrose, 1996), extending the proposal for long-range quantum coherence (Fröhlich, 1968a, 1968b) via microtubules. Penrose argued for non-Turing decision-making, in the line of Turing's morphogenesis, Neumann's non–von Neumann class computing. Gravitational collapse of many entangled decisions is the foundation of the orchestrated objective reduction (Orch OR) theory.

Evolution of the brain: All the functional parts of a dinosaur's brain did not evolve homogeneously to humans. The human lower brain has remained nearly the same as that of a dinosaur, while the frontal lobe has increased at an abnormally high rate. The discovery of cooking food during evolution suddenly increased the human brain activity, as they could devote time in creating art, science, and culture, unlike other species. It is also debated if all living species are conscious. Here, we would explore an engineering way to find an answer. For sure, the advent of enormous complexity in the frontal lobe is the result of human's unlimited quest to find the smallest, making the smallest, reach the farthest, and build the finest; however, that does not give a human a license to be the sole owner of consciousness. Breaking the limit, playing with the limits, and redefining the limits are our daily job, putting tremendous pressure on our frontal lobe: so much so, that in the next few million years, human brains may look something like an ellipsoid. The human brain would grow vertically upward, because eventually, it would have to come out of the mother's womb and expand. Moreover, one cannot afford to increase the brain and the skull further, since symmetry in the skeleton is essential to withstand the enormous pressure of gravity and at the same time keep the balance of the body for moving forward. So the human brain and body are evolving rapidly, even right now, and symmetry is playing a vital role (Bartol et al., 2015). At the same time, with the increasing brain size, axon wires in the neuron's core increase in length and/or width. The longer or bigger wires have less noise in sending signals, but require a much higher energy consumption; therefore, probably the human species is the result of an optimization experiment of nature between an elephant and a honeybee brain. Thus, often it is argued as if a "limit of intelligence" has been reached (Russell, 1948). If evolution is oscillatory, then the next evolution of humanity is a zombie, if there is no quantum jump (Figure 10.12).

1.4.1 What Does the Information Look Like in Nature

The geometry of silence: When one reads this line, no algorithm is instructing one's brain. As we read, proteins in the neurons are clocking at picoseconds, nanoseconds, and microsecond periods so that the millisecond-scale membrane firing is executed properly. Instantaneous perception is a loop-like organization of events, arguing against the universal arrow of time (Zeh, 1989). Pure vibrations in the brain's materials are doing the math, simulating the future, and making the decisions: everything that a computer can do, even much more, but without a single line of software code or algorithm. One has to build a protocol to do everything in a non-algorithmic way. Natural vibration of materials is the only event given to us to make an artificial brain. Then, we need a way to link all the vibrations in nature and within us: an integrated information-processing at multiple times and spatial scales layered one above another, connecting atoms to the entire brain and the whole body. All vibrations are connected by a pattern, an invisible geometric shape, but we needed to know the universal rules of integrating these geometries. The pattern of primes being explored here we believed to be at the core of every single self-operating system, as at the core one PPM talks to another PPM (Figure 1.4c).

Music has been an art of silence, but scientists were looking for screams. Often, we think that geometric shapes could acquire infinite shapes, but all tribes across the planet for thousands of years have stuck to a few geometries. We selected 15: five lines, five areas, and five volumes. The demand for building a metric of information is not new (Zurek, 1989); what's new here is the use of 15 primes. The saga of thought neither begins nor ends at any level; the pattern of primes governs every single event in the universe that is happening, has happened, and will happen. The pattern of primes replaces the need for an algorithm: we link the pattern to drive materials synthesis, so that synthesis of materials is the synthesis of time crystals made of magnetic atoms, which is the synthesis of thoughts in an artificial brain.

The physical origin of time asymmetry: However, time is topologically an enclosure, a loop. If we try to write an

event on a circle as a topology of distributed pixels, where each selected pixel is a subevent, then the "gap" between the subevents on a circle is important. The physical origin of time asymmetry is unknown, but the singularity-emitted magnetic vortex atoms reveal that a prime, a nonlinear asymmetry, is in the unit of information itself (Figure 1.4d). The century-old debates on the topology of time considered whether

1. the events on the perimeter of a clock are truly linked
2. the coincidence requires both spatial and temporal locking
3. acceleration or deceleration of clocks happens only due to the unbalanced forces
4. measuring a clock means comparing time
5. stating that A causes B is impossible unless we mark the event using a marker
6. space travel is possible, time travel is not, the boundary condition sets this time asymmetry (van Fraassen, 1970).

Then, it is not space-time: the phase is fundamental. Instead of an unbalanced force, the addition or subtraction of singularity points accelerates or decelerates the clocks. Measuring a clock is not comparing but sensing the symmetry. The origin of time asymmetry is not a boundary condition, but a pattern of primes that invents a large number of simple geometric rules that, if implemented, generate an infinite series of randomness (Wolfram, 2002). One immediate conclusion of the phase metric PPM is that

1. the universe is an infinite 3D network of clocks (metric of time), with no need for eternal recurrence or cyclic recurrence;
2. time asymmetry or unidirectional flow of time in the future is conformal since only a few geometric shapes repeat and always in a circle. The past, present, and future at various places in the infinite network clocking geometries act as an integrated singular geometric entity, the past-present-future. The present holds the future, not otherwise (block universe = no future; Broad, 1923). Thus, the physical origin of time asymmetry in a 3D network of arrows in various directions is guided by a pattern of primes. Depending on the direction, one clock would see future or past or present events for the other clocks. Velocity in those clocks is a function of who and where.

Geometric musical language (GML) is an extension of Wheeler's geometric universe: Grossman's adventure with geometry hidden in the tensors provided Einstein's dream on relativity a mathematical ground, and it inspired many to conceive a geometric universe. Wheeler envisioned reduced physics into a pure geometric event in an even more fundamental way than the Arnowitt, Deser and Misner Hamiltonian formulation (ADM) (Arnowitt et al., 1960a, 1960b) which proposed to reformulate the general relativity with a dynamic geometry whose curvature changes with time (geometrodynamics; Butterfield, 1999). For example, the geometric shape would change such that we would get (1) mass without mass, (2) charge without charge, and (3) field without a field. However, a paradigm shift is essential while conceiving geometry. Instead of slicing the space-time into arbitrary geometric shapes, fill everything with that slice. It is essential to consider the singularities as the corner points of the space-time fabric and build up the network of geometries. Singularities talk to each other, be it a big data or neurons in the brain; repeating events burst with noise when they cross the singularities, and those clocks hold the geometries.

If there are three singularity points, we get a triangle; thus, unlike geometrodynamics, here the geometry is not related to space or time; it is a geometry of silence. While constructing the geometric language, the quantum concept of a Bloch sphere undergoes three major changes: the sphere has no classical or phase-neutral point, it has holes and it has clocks. In this universe, classical continuity does not exist, and an explorer of the universe ignores the century-old madness to cover the empty parts with a quantized fabric, the goalpost, and vision and route get an overhaul. If there are three layers one inside another, across the imaginary worlds we get a triangle of the observer, observed, and the environment; this time crystal has no location, and even its identity is spread over. The time crystal is the unit of information in the universe; one could calculate information entropy and mechanics linking the black holes spread all over the universe, and a conversation of black holes is emulated to build the artificial brain (Chapter 10). Changing geometric shape is the discretization, for quantum and gravity become now a journey from one singularity to another (Wheeler, 1979) for GML. The boundary of a boundary is zero; the geometric algebra of 11D gaming of circles ensures nothing in between two singularities, yet they talk; it is obvious in the elementary particles (Kheyfets and Wheeler, 1986).

What is phase space, Bloch sphere, Hilbert space? A phase space is like a mask, passing through which the input geometries morph into another shape. A phase space is derived from the dynamics regulating the parameters of a device which bridges the input query to the output required by a user. Bloch sphere is an example of a phase space where on the surface of the sphere an infinite number of energy levels between two entangled states reside. Infinite possible choices between two classical observables are the Hilbert space, mostly painted on a sphere.

What is a singularity? A singularity is a gap in the phase space, where the phase structure of a typical biomaterial is undefined: the output is irrelevant to the input. In these conditions, a system resonantly vibrates, emits, or absorbs the signal of a particular frequency. There are many different types of singularities; for example, phase singularity, polarization singularity, and amplitude singularity. Singularity points are the corners of geometric shapes in the phase structure of a spiral or vortex. A system point passes through the corners one by one; if in a loop, it's a clock. The signal bursts when the system point passes through the singularity points located on the loop that defines a clock. The singularity that Feynman

eschewed in his renormalization (Feynman, 1949; Cao and Schweber, 1993), the 3D phase structure, holds the Feynman paths as a minor subset in the geometric shapes. Thus, the universe in the time crystal model blinks, spontaneously creating a vertical Turing tape in the cell of a horizontal Turing tape (see Figure 1.5a).

What is a time crystal? Just like a singularity in space creates a crystal of matter, a singularity in phase builds a time crystal. A spatial crystal has three orthogonal position axes, and time crystal has three orthogonal phase axes. Time crystals are nested bubbles with a clock in their great circle. All bubbles hold geometric information; if a bubble holds a triangle, three points on its great circle are undefined singularities. A singularity point can either hold a network of bubbles inside or bind with the neighboring bubbles. Thus, singularity glues an architecture of the time.

1.4.2 Why Two Individuals Understand Each Other or the Universe

One conscious being already knows what the other conscious being would say: The quantum and classical worldviews are two extremes. In Figure 1.5b and c, a cartoon is drawn to depict why they need humans or gods to explain nature. For classical, the tape needs to be infinite, and for quantum, it's a vertical line of entanglement; if we break it, the universe would be gone. The ideal scenario to get a machine for consciousness would be talking one-to-many and many-to-one at a time (Figure 1.5d). In machine terms, consciousness is not everywhere: it emerges from a set of instructions encoded. This book is not for endorsing the idea of panpsychism using PPM, because it requires a special feature of harnessing the PPM via a time crystal for realizing the consciousness features defined above. It is an inverse transformation of the vibration chain that links all singularities and which can synchronize at any point inside or outside the body. Consciousness is not a state of matter, but a dance of a set of symmetries linked in a 12-layer hierarchical geometry. Consciousness is also not integrated information: nature links resonant oscillations in a band; that is, singularities or black holes form many groups, but groups with a prime number of holes self-assemble to build higher-level groups.

Mathematically, a conscious machine that can verify whether a robot has passed the Turing test or not (Figure 1.6a) is like an axiomatic deductive system that can refer to itself: PPM perfectly satisfied this criterion (Smorynski, 1985). PPM is a generic term and has primarily three classes: one that links integers, one that links groups of primes, and the last one that links prime gaps. The integer class does not have one but 10 different forms; the metric therefore morphs as required, and thus it is a system that deduces axioms (Chapter 3). The advantage of PPM-driven hardware is that it can replicate events happening in nature in its own vibrational string because of its high density of resonance frequency and the length or bandwidth of the resonance chain; both are important factors.

To build a good mirror of nature, one may choose billions of light-year domains, select a string, and increase density of resonance peaks to cover 15 primes in 12 layers. One could build a similar conscious machine in the femtoseconds time domain. One of the very exciting aspects of such a hardware is that the accessible, immediate environment could get mirrored in its own vibrational chain. By inverse transformation, this is also logically possible: that the entire vibrational

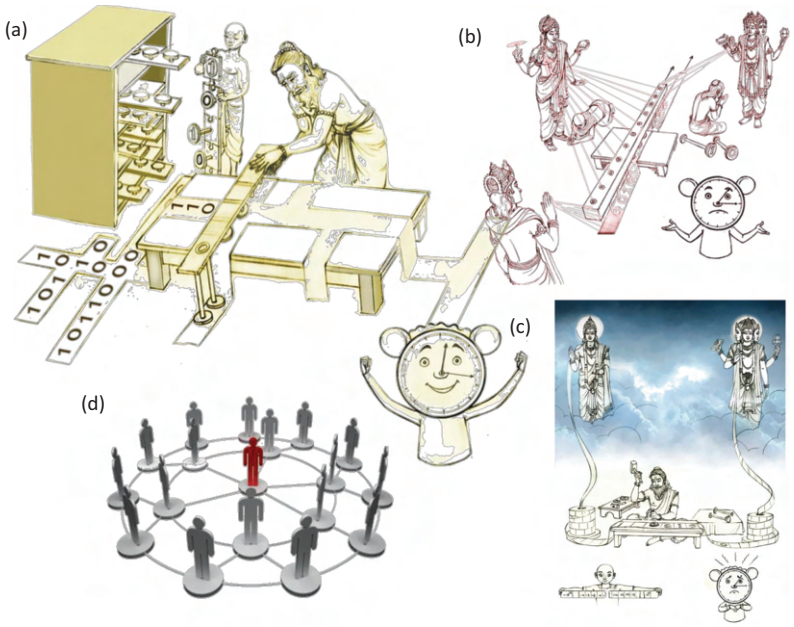

FIGURE 1.5 (a) The philosophy of new kind of tape, where sequential and simultaneous events coexist. Simultaneous events are depicted using a vertical tape, i.e., cell inside a cell. (b) The philosophy of quantum tape, where there is only one vertical tape. (c) Turing tape suggests to rewrite all events that were happening around us as a sequence of events. (d) One-to-many and many-to-one is a philosophy represented with a person in the center and others all around.

(c)

Vedic Philosophy	Frequency fractal philosophy
Nothing is touched, everything is pure, universe is alive, unit of information is alive.	All points of a Fractal hardware cannot be touched. Universe/information follows infinite pattern of primes.
Eternal vibration is everywhere, connects all, no beginning/end. There is no space only time.	Fractal resonance chain connects everything in this universe. Only phase no time.
Consciousness is universal, all are organs of a higher life.	Hierarchical network of time crystals governs phenomena
Consciousness is a music, with 22 tonal patterns, 12 primes	A metric of primes (12 primarily) links all symmetries.
There is no free will, it's purpose of everything is to evolve into a higher life form.	Every life is part of an universal resonance chain, any vibration in this chain is part of the vibration of a global chain
Actions are not left alone, it affects everything in the universe, irrespective of distance. Time crystal is truth.	Any local changes in the resonance chain affects the entire resonance chain, and vice versa. Time crystal truth.
Geometry of silence carries the message of the universe.	Geometry of silence holds the information of time crystal.

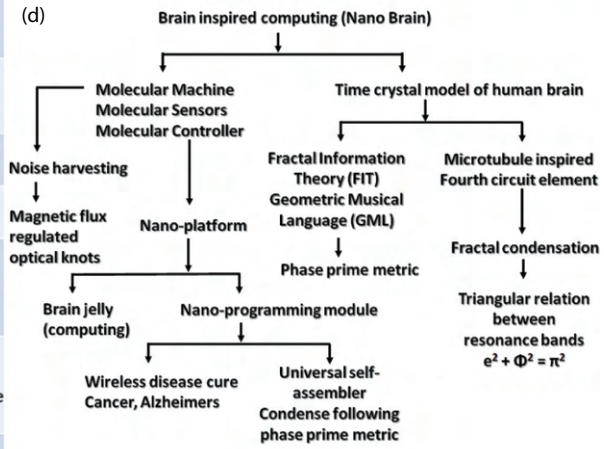

FIGURE 1.6 (a) Turing test. In one side a computer or a human hides. Another human sitting on the other side tries to identify who is interacting, the human or the computer. (b) A circle on the sphere changes its diameter but the geometric shape is retained. To the right, a human is shown in multiple conformations. To the extreme right, the evolution of astrophysical objects and the embryos have similarities; in both cases prime numbers do play a role. (c) The difference between Vedic philosophy and frequency fractal philosophy is shown in a table. (d) A diagram shows the different discoveries associated with the development of an artificial organic brain, i.e., nanobrain.

chain of our brain cum body is replicated in another point of the universal resonance chain, mirroring two simultaneously editable complete information architectures outside the body (including one totally inside) at three points. This is defined in this book as consciousness or self-awareness. Following this protocol, one can determine the degree of consciousness in an object by measuring its length of resonance chain and the density of symmetry breaking points together. To build an artificial brain, the consciousness must be outlined at the beginning, because an astronomical number of theories exist.

> The plurality that we perceive is only an appearance; it is not real. … the many-faceted crystal which, while showing hundreds of little pictures of what is, in reality, a single existent object, does not really multiply that object.
>
> **—E. Schrödinger; "The Mystic Vision" as translated in *Quantum Questions: Mystical Writings of the World's Great Physicists* (1984) edited by Ken Wilber.**

1.5 DIFFERENT KINDS OF TAPES TO RECREATE NATURE IN DIFFERENT LANGUAGES

The geometry of music is key to our thoughts and is not algorithmic: To gather knowledge about the universe, humans use a generic mathematical "inference device"; this device transforms into an observation device, a control device, a prediction device, and a memory device (Wolpert, 2017). This book investigates a new inference device, shown in Figure 1.5a, that is different from the concept of the entangled universe, shown in Figure 1.5b. As Figure 1.6b outlines, the geometric expressions are conformal; that is, be it big or small, a triangle would always be a triangle on the phase space. However, the duality of different identities emerges from the phase space only; be it a journey of an atom or the big bang, the creation of an identity is a game of primes.

Many researchers now seek an inference device that talks to many at a time, like in Figure 1.5d; researchers reject the century-old classical inference device (Figure 1.5c) that believes, irrespective of complexity, any event happening in the universe could be explained as a classical sequence of an elementary singular event. It is difficult to confine a free will in a logic (MacKay, 1960). The ripple effect of this minor change is dramatic. For example, the current neuroscience tells us that intelligence is in the brain alone, our memory is in the neuron junction, and a neuron's skin does all kinds of information processing. It is similar to the belief that our intelligence is in our skin; after all, our skin does everything. If we consider that the 3D geometry of clocks replaces a human body, then our memory is located everywhere, and

a decision is made in the geometry of vibrations, not at any particular location, so searching for consciousness in any particular part of the hardware is a misadventure.

Living life with primes and geometric language: Figure 1.6c compares the new class of geometric computing. Indian raga is a geometric mathematical seed, which has specific notes when steps are taken in the direction of increasing frequency and then in the direction of decreasing frequency. When the music unfolds, this basic geometry created by ascending and descending notes is kept intact; the expansion (Vistar) is similar to PPM-based amplification via transformation of a geometric shape. In spite of incorporating another pattern, the basic geometric construct remains fixed; thus, the self-similarity which is a key to the fractal representation is maintained but appears very different at every scale. Mystical beliefs often resemble the scientific arguments: three-thousand-year-old Sumerian cultures and faiths helped the Greeks and evolved into many axioms of modern science. Similarly, four-thousand-year-old Vedic scholarly arguments that the universe to its extreme limit is alive (Viratapurusha), and there is an infinite network of life one inside another in an endless chain, are accidentally similar to the fractal tape explored here. Figure 3.12b and c is strikingly similar to the geometric language and information theory derived from proteins (see also Section 10.9).

Tribes across the globe use primes as holy seeds; similarities could be mere coincidences, but we note Vedic numbers because of the actions and significance attached to these primes. Some examples follow:

- Twenty-three tonal patterns of Indian classical music for a perpetual elementary rhythm (Brahman) govern information processing at all levels.
- The evolving self-similarity of a classical song resembles the prime-driven GML: 108 rhythms generate consciousness (12 triplets of triplet bands, Ghosh et al., 2014; $9 \times 12 = 108$).
- An avatar puts his/her mind into a singular state for 144 seconds (12 meditations, one meditation = 12 second i.e. dodecanion tensor is $12 \times 12 = 144$).
- Patanjali's 8 levels of consciousness include 7 transitions (octonion tensor, $8 \times 8 = 64$, number of qualities the universe or Viratapurusha possesses).
- Fifty-one yoga poses were proposed at 200 BC for worshipping deities.

1.6 BRAIN-INSPIRED DECISION-MAKING—THE OUTLINE OF KEY DISCOVERIES

***Within* and *above* means a journey through multilayered imaginary worlds:** In quantum, one imaginary layer brings spooky action at a distance: when multiple imaginary worlds coexist, they exponentially impact the reality. Simultaneously many channel interactions among the imaginary worlds become a key factor, demanding a new algebra, a new mechanics. One of the remarkable aspects of coexisting multiple imaginary worlds separated by speed limits or several boundaries of action (analogous to Plank constant h; Figure 4.5) is decision-making procedure. The decision taken at different interactive imaginary layers could impact a non-participant imaginary layer. By the time a cascade of interactions impacts the reality, the logical mind surrenders any intuition or argument to predict. We do not always need a very high-speed communication or entanglement to demonstrate the harvesting of interactive imaginary worlds. We can artificially create a nested fractal structure in which each layer is a universe, with a maximum and a minimum speed of carriers following a specific action value like the Plank constant. For centuries, mathematicians were struggling for binion, quaternion, and octonion, now we take that journey to the dodecanion, to a point, where for the first time, 12 layers acquire (Figure 4.13) the ability to self-operate. Now, the lowest universe, holding the reality sees only accidents as a reason that an event is set at the higher world, which it cannot observe. The middle layer feels that accidents are generated at a higher level, and information disappears at the lower level, like the data source and data sink. We finish this book with a table, where we have outlined how the journey of dodecanion would bring forward the technologies of the unseen (Figures 1.6 and 10.12).

1.7 ENERGY TRANSMISSION IN THE BRAIN—IT'S NOT ALL ABOUT NEURON SKIN

Popular articles on the Internet always talk about the ultra-low power used by the brain, only 20–25 watts, but they do not split it into different contributors. We took every factor consuming energy in the brain, estimated how each component spends energy, and calculated how many of these elements are present in the system. Thus, we got the total energy spent by a given element. The wheel of energy plotted in Figure 1.7a tells us that neuron firing is not everything. This book does not cover the soliton, but if we are not biased, we found that maximum energy would be spent by solitonic transmission. The second-largest consumers are the filaments, which are ignored in the brain's information-processing theories.

Three pathbreaking discoveries in the biological system: First, the existence of a chain of resonance frequencies (Figure 1.7b and c)—be it mechanical, electrical, or magnetic—as the frequency peaks shift in a group of primes, unveils a lot (see Chapter 5 [Sahu et al., 2013a, 2013b, 2014]). Second, the chain builds rhythms at various time scales that control the biological phenomena by long-range feed-forward communication and often energy transmission 1,000 times faster than those that are observed in molecular, ionic biology. Third, several helical biomaterials exhibit quantum and classical cloaking at a resonance that enables far-distant neighbors' seeing and communicating, even if there are millions of helical cloaking devices are in between. It has been experimentally shown that the basic engineering theme for nature to construct a biological system is "keeping time," which is basically carrying out a precise movement of its components so that the perturbation created by the environment in the

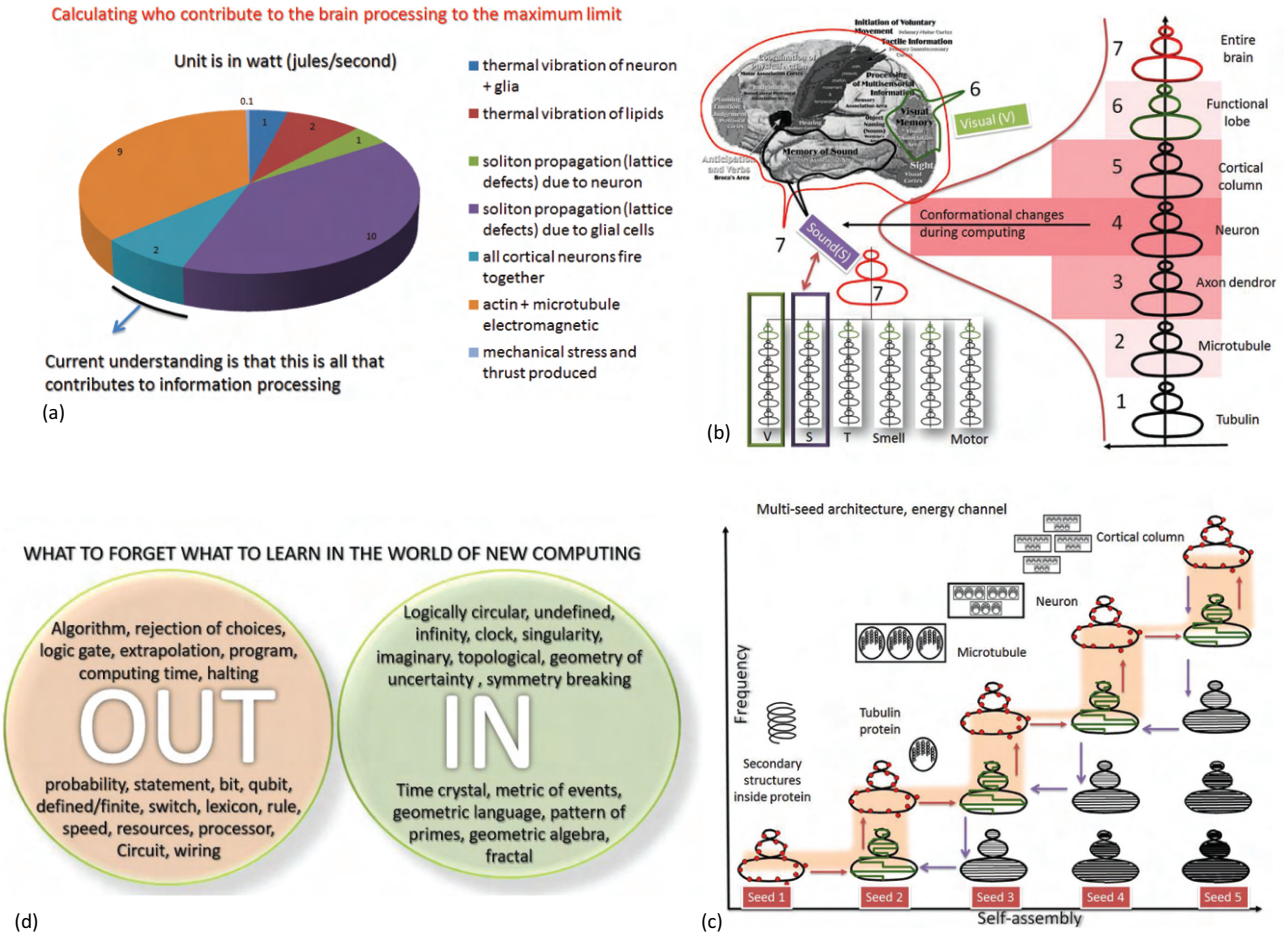

FIGURE 1.7 (a) Energy expenditure has been calculated for different sources of carrier transport in the brain and associated neural network. (b) Seven prime layers, one above another, involved in the decision-making process of the human brain. A Gaussian distribution is shown to depict the contribution of different components in decision-making. (c) Spiral- or vortex-like structure forms a Hasse-like energy transmission diagram in the human brain and its decision-making network. (d) Non–Turing based computing follows several fundamental basic features which do not exist in Turing-based computing.

rhythms inside is met outside, and harmony is established between the two worlds. Ion exchange and membrane potentials are the secondary expressions of the primary electromagnetic communications; ionic clocks are expressions, not the governing rhythms. The membrane potentials are essential for mechanical thrust to rewire the neural branches (Ghosh, 2016a; Agrawal et al., 2016c), hence no part of the existing biology needs to be discarded, but ionic- and potential-based biology is only half of the picture when all other kinds of polarizations are ignored.

Resonance spectrum of biomaterials contains a hidden geometry: Resonance peaks of a biomaterial are not random; they form groups and shift together like geometric shapes (triangle, square, etc.). Geometric shape canals the energy transfer, forming a chain of vibrations; one can see an entire assembly as a 3D collage of geometric shapes. One could extrapolate this idea to the entire universe or the human brain because we see spiral symmetry everywhere. Every single biological system is a small string or a guest time crystal and tries to match that universal chain of vibrations or become a part of the host time crystal. PPM governs but a projection of its infinite series from infinity causes unwanted changes in the evolving multi-PPM network; the changes caused in the biological body are the evolution. If there is a topological control of mind, deep learning is also a black box, and it does not work (Nikolić, 2017); the geometric view of Wheeler advocates not a traditional triangular control of mind, but a metric of geometric shapes.

Electromagnetic resonance and quantum cloaking: We all wonder about the chemical brain rhythms: there is only one type of carrier, ions, and only a short frequency band in the millisecond time domain. Microtubules that pack the neurons and deliver strength, a unique triplet of triplet resonance bands, or three resonance bands each with three sets of resonance peaks, were observed (see Chapter 6). When a neural membrane and the proteins that make a microtubule also exhibit a triplet of triplet resonance, a scale-free fractal feature exclusive to the typical pattern of primes PPM reminds one of

the various historical accidents of Efimov trimers (Adhikari and Tomio, 1982). Carina Curto observed that when a neuron fires, the spikes group in 3,5,6,7,9, and this group repeats; it's one of the infinite possible groups. The key is that spikes form groups of groups and hold geometric information (Curto, 2017). Thus, the idea that the neuron's skin is doing everything as it was tagged in 1907 might require a revisit (Brunel and Van Rossum, 2007).

If AC electromagnetic energy is pumped into these biomaterials, at certain frequencies the materials turn transparent and disappear in the presence of a matter wave: so we call these frequencies the resonance peaks. Proteins, DNA, collagen, and other biomaterials have shown similar resonance behavior, with classical and quantum invisibility in the same frequency range. One of the striking features of these resonance bands is the coexistence of positive and negative peaks, which suggests that when two such oscillators engage in the energy exchange, it happens in a cyclic loop. Thus, rhythm is born even at the scale of two molecules.

If one wants to build an exaflop computer (10^{18} bits per second) one step ahead of the contemporary best, it would require a nuclear reactor producing a few hundreds of megawatts (power); any operation that requires a resistor would generate heat. In contrast, our brain operates by spending only ~25 watts (Figure 1.7a). How could the brain operate using such a low amount of power? It is believed that the major source of brain energy is available as thermal noise in the environment, which is harvested by proteins (see Chapter 5). Therefore, the research on creating the molecular machines for harvesting the freely available thermal energy is a key component of making the artificial brain and a key to replicating the protein-like energy management (see Chapter 9).

Most brain builders ignore the details of brain architecture; a carbon copy of neuron circuits is the global motto. However, here, no structure is left out, but we do not see the structure as is: we look at the symmetry of the components in a system at all spatial scales from DNA, from proteins to the glands, hippocampus, and so on. What is the symmetry of a material? It is the arrangement lattice of the components a system is made of, not how many of them are out there. The presented brain map here is a catalog of symmetries coming together to build a higher symmetry: not a wiring of space but the wiring of undefined regions where an arrangement cannot vibrate. In a gold crystal, using symmetry, we neglect billions of atoms; when energy is pumped into the crystal, the plane of symmetry absorbs or releases the energy as a single unit, and individual atoms do not absorb distinct energy packets. The absorbed or released energy transfers the active plane of symmetry from one to another; under continuous energy pumping, the system switches between two symmetries repeatedly, and we state that the symmetry breaks continuously. A particular form of energy selects a particular plane of symmetry in the material at resonance; a rapid oscillation of the plane makes it noninteractive. Most signals pass through the plane without interacting; microtubule resonates at around 6–8 GHz, where we found it exhibits quantum cloaking. At the same frequency the DC resistance drops by 10^3 orders; obviously, electromagnetic resonance vanishes, and the electron and the matter wave tunnels through the plane. If there are multiple resonance frequencies in a system (band)—electronic, magnetic, and mechanical resonances driven by ions; electrons, photons, and quasi-particles—each carrier chooses a plane for a particular frequency.

High-frequency signals may interact with the atomic orbitals, while very low-frequency signals may interact with the plane of symmetry of a giant organ, like the entire left and right brain's cortex regions. Switching between the planes defines the clock time; the charge is stored in the plane in a pattern to hold memory, and vortices read the vibration of the pattern as a time crystal. Light builds the time crystal of magnetic vortex atoms, an electric field–induced ion flow creates a time crystal of ionic vortex atoms, mechanical vibrations build time crystal of solitons, and so on. Now, a part of energy could vibrate the plane of symmetry physically; its mechanical resonance, its frequency of oscillations, varies widely. Electromagnetic signals travel at the speed of light; however, if the electronic charge forms a quasi-particle, then it cannot move faster than the speed of sound. Here in this book, we will use the word *resonance*: in general, it would mean 12 carriers and 12 types of rhythms (Chapter 7); however, for biological systems, the mechanical, electromagnetic, and magnetic oscillations occur simultaneously. The genetic and biological basis of human language is unknown. However, the language-processing region of a human brain is not actually a key part of language processing, which is universal and predates humans.

1.8 TERMINOLOGIES OF LIFE THAT COMPUTERS DO NOT SUPPORT

The current estimate is that a synapse stores 4.6 bits (Bartol et al., 2015). Since this estimate, the philosophy has been to combine as many processors as possible: the bigger the number, the more powerful would be the brainlike machine. No one dared to start building a computer in which encoding software would not be necessary, where power consumption is minimal or negligible, and where arguments are not discrete elements; rather, computer intelligence was seen only as a network from which discrete arguments could not be isolated.

Eventually, we had to change our thought process, the terminologies must change from the universe of logic to the universe of nonsense (Figure 1.7d). The human brain or the universe that operates by itself would be an architecture of time, no matter what they would look like physically. Atoms and crystals and all analogs of matter would be created using vortices of fields, as ingredients to synthesize an architecture of clocks that operates by itself. No black box magic, no accuracy of the data—we need to have all the limitations that a brain has; for example, it becomes very difficult for a brain to even multiply two numbers without using a reference paper, which helps the brain to create multiple reference points between the starting point and the endpoint of a calculation. An entire human life could be a single clock completing only one cycle, holding entire lifetimes of decisions within (Figure 1.8).

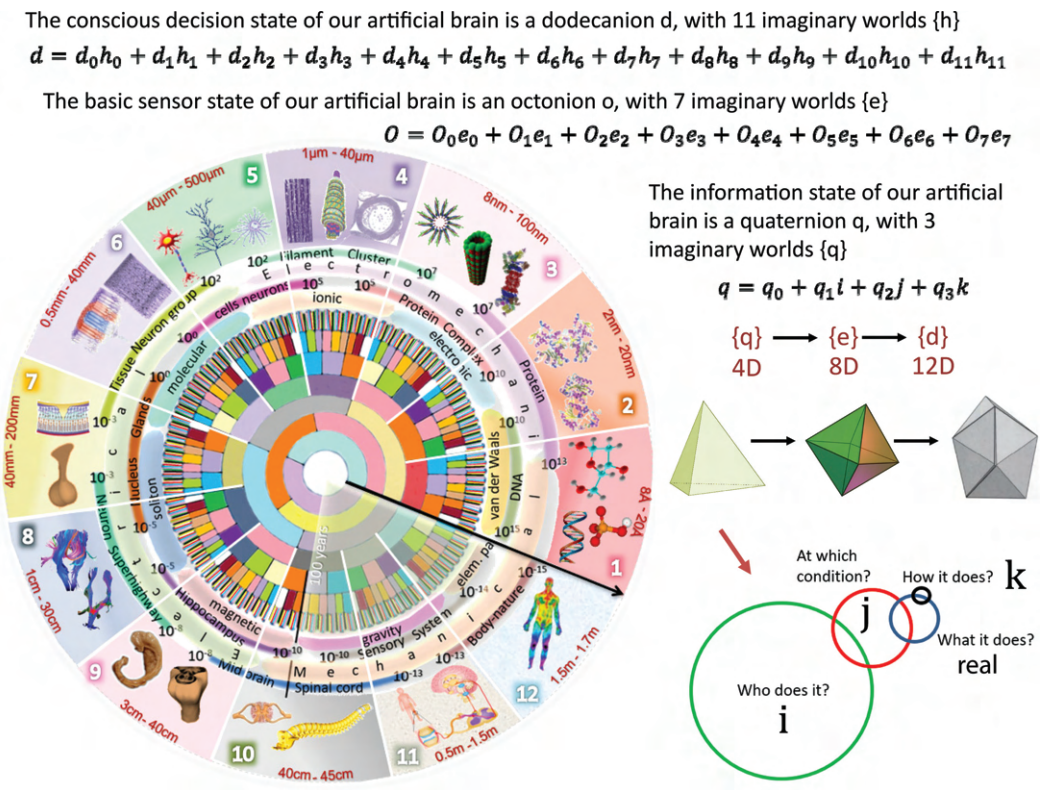

FIGURE 1.8 Frequency fractal model of the whole brain. It is made of 12 conscious decision-making tensors {*d*}. Twelve interactive forces, starting from the elementary molecular structure to the whole body, are part of a single resonance chain. We have divided the brain into 12 different bands, representing 12 conscious components, holding 12 types of memories by 12 classes of rhythms. This is 2D representative version of the time crystal model proposed in 2014 by Ghosh et al. Currently we have discarded this model and advanced to time crystal representation of the whole brain. Three tensors define an artificial brain: The elementary or basic unit of information is a 4-dimensional quaternion tensor, *q*; it builds an 8-dimensional octonion tensor *o*, which builds a 12-dimensional dodecanion tensor *d*. Each tensor is represented by a 3D geometric shape; for *q*, *o*, and *d* we used a tetrahedron for quaternion, an octahedron or Siamese dodecahedron or dodecadeltahedron or a cube for octonion and isocahedon for dodecanion, respectively; all structures are made of triangles or square, and each plane represents a dimension. The linguistic version of quaternion is shown below. This is the unit of information in the brain; only the real part of quaternion (what it does) is sensed by a sensor.

Existing computers are faster and have more memory; there is no question here of competing with a quantum or classical computer. It's a journey with a vow to not use advanced algorithms, but rather to see events much more intricately, building an engine of clocks that would emulate this unknown engine and building an information stream that the unknown engine would generate in the future. In the case of data deluge, where millions of parameters vary simultaneously, writing algorithms is next to impossible. The pattern of the most active and most inactive points (both are singularities) demonstrates how intricately key factors are related.

Perform a search without searching: Spontaneous reply back: If the clocks are cleverly arranged in a suitable geometry, we can encode an enormous pattern in a limited number of oscillators using a few clocks, which would run to generate newer patterns continuously. GML delivers a static clock structure for a rapidly changing big, complex data. Unlike classical and quantum search, when patterns are matched pixel by pixel in a set of time crystals, the right pattern spontaneously replies, because the already memorized time crystals ran continuously in a silent mode. The one that is to be found becomes a seeker. The artificial brain compiled here wants to expand its PPM continuously and perpetually. It is a user of nature: the artificial brain is about building a user, not a computer. If a PPM-driven artificial brain finds asymmetry and by simulating the future finds how to regenerate symmetry, only then it replies; it's not a machine, nor does it compute.

1.9 LINGUISTICS AND THE WHEEL OF SPACE, TIME, AND IMAGINARY WORLDS

While formulating physical laws, one assumes that at one time only two particles are present; everything else in the universe is considered nonexistent. At the very next moment, we consider a new pair of particles, as if all the rest have vanished from the universe. Finally, abolishing the true concept of time, these laws are made to fit human perception. PPM sets a new clock seeking laws that link symmetries, via fractal mechanics, which holds 11D data in a 12D tensor (Figure 1.8). FM sets the principles of the language of all possible dynamics; one could realize 11 nested classical layers to create the 12D artificial brain as explored here. Else one could have 11 imaginary layers:

one layer represents quantum and the others beyond quantum. Thus far, simultaneity was not backed by science: one-at-a-time events do happen, but what is that universal factor which can evolve two coupled or entangled entities together? The answer is that both the entities are PPM. When one writes two sets of primes, both evolve together, even if they are universes apart or entangled atoms in a simple molecule. Similarly, no communication is required, as the researchers have argued, because both of them know already what the other knows.

The problem with the current paradigm of classical and quantum mechanics is that the significance of a phenomenon is the joint product of all the evidence that is available only from those who communicate (Follesdal, 1975): no communication means no significance in the law. Even now, we add more and more functions to compensate the loss of an astronomically large number of simultaneous contributors; in science, we never built a methodology to estimate those who do not communicate at all. We named the compensation as a many-body theorem (Thouless, 1972), which is a never-ending optimization to reach nature's true reality. However, what is lost in the simultaneity once, could never be recovered. Brilliant fusions (e.g., multipartite entanglement) did not provide the true picture of nature because, again, two extreme views of nature, classical and quantum, need a generic mechanics that would consider many imaginary worlds, and while the classical neglects it completely, the quantum considers only one imaginary world to paint complete truth of nature. Both are incomplete, since what that is silent now is communicating in the geometric phase; 11 imaginary worlds interact with one another in the intricately connected phase space, all at a time—it's spiral of a spiral…. The phase path is always active.

In 2010, a *Nature Physics* article examined how Feynman's vision, proposed in 1962 to replace the basic physics laws with the change in certain geometric shapes, was introduced (Bandyopadhyay, 2010c). That article also tried to bring Wolfram-Conway's game of life into life. However, the language of equations cannot represent nature and the language of cellular automatons could not explain nature. We are exploring a new language of the time crystal, GML, that it could be a 3D topology of clocks representing the same theories in science in significantly simpler formulations (see Chapter 4 for a few simple examples on quantum mechanics and mathematics). For streamlining the events, the equations containing an infinite series often result in apparently nonphysical unrealistic significance; e.g., see Ramanujan's $-1/12$ derivation as the sum of n natural numbers, $1+2+3+4+\ldots.+n=-1/12$. The geometric algebra introduced here actually feeds $-1/12$ back to the input decisions: not once, but at least 10 times cases have been found where physical events happening around us are being perturbed by the eventuality of that infinite series. It is an important factor which suggests that even logically the language of defined states in the Turing tape could never reveal nature's true picture. Projection from infinity is the reality, though; instead of a two-body problem, now it's a prime-body problem. The universe is being seen in terms of the 15-prime system, which covers 99.99% of it; this is primitive yet the first step to finding the language of nature.

1.10 THREE CONCEPTS DEFINE ARTIFICIAL BRAIN

Figure 1.9 outlines the fundamental core of the artificial brain: synthesizer of magnetic vortex atoms, a linker of symmetries, and a language of the universe. These three columns might lead to three cultures: one that replaces current voltage culture with magnetic flux–charge culture; the second, time crystal engineering that harvests noise; and in the third, time is fundamental.

Did some mathematicians, through their love of primes, create the human brain? Magical integers play between short-term memory (STM) and long-term memory (LTM), and these integers are primes (Cowan, 2001). Our sensory systems are paired: 2 eyes exhibit prime 2. We have 3 major parts of the cortex, and one could notice 5 distinct domains in the connectome branches. There are 7 layers in the cortical column, and 7 retina columns harvest light. All animals on the planet have 13 protofilaments in their cellular microtubule. There are 17 regions in the hippocampus, where 37 rings filter the brain's input–output signal. Often in textbooks we find 23 types of branching in the neurons, 23 types of glial cells, and 13 types of oligodendrocytes. There are 31 spinal nerves; with 12 cranial nerves we have a 43-peripheral nervous system (PNS) to sense the world around us. A series of primes, 1,7,19,37…, around 200,000 hexagonal close packings of cortical columns make our decisions in 47 Brodmann's functional regions. Singh P. (2018) made 100,000 organic cortical columns made of 7 organic gels in each column for a humanoid bot. The use of primes is endless. Nature wanted to implement PPM in the brain–body decision-making network, so that everyone needs to communicate very little yet create a similar worldview. That's why, we noted earlier, be it a human or a single molecule, we already know whatever that could be said to us, no one could reveal anything new to us. In any part of the universe or brain, communications are coded to locate and operate PPM.

The problem with the molecular neuroscience is that it does not want to look beyond its faith that everything under the neuron skin must be silent. Now, in the GML paradigm, when a time crystal needs to be transmitted from one junction to another, one particular frequency channel in the resonance band could be allocated for a particular neurotransmitter molecule (Ghosh, 2016a). Inside the axonal and dendritic branches, the electromagnetic signal propagates 250 microseconds before a neuron fires (Agrawal et al., 2016c). The mechanical, electrical, and magnetic resonance frequencies of the filamentary bundles inside a neuron follow a vortex identity $(e^2+\theta^2=\pi^2)$. Geometric ratios of neural branches do not explain why and how the neural wiring works. The 3D folding of shapes is the topological event of identities set by 12 types of resonances found in the biological systems (Chapter 7), and one could regulate the formation of biological structures only to build the respective time crystals using a particular set of symmetries (Hughes, 2018).

Prime integer 7 regulates a human brain's capacity to process information (Miller, 1956). At the core of the

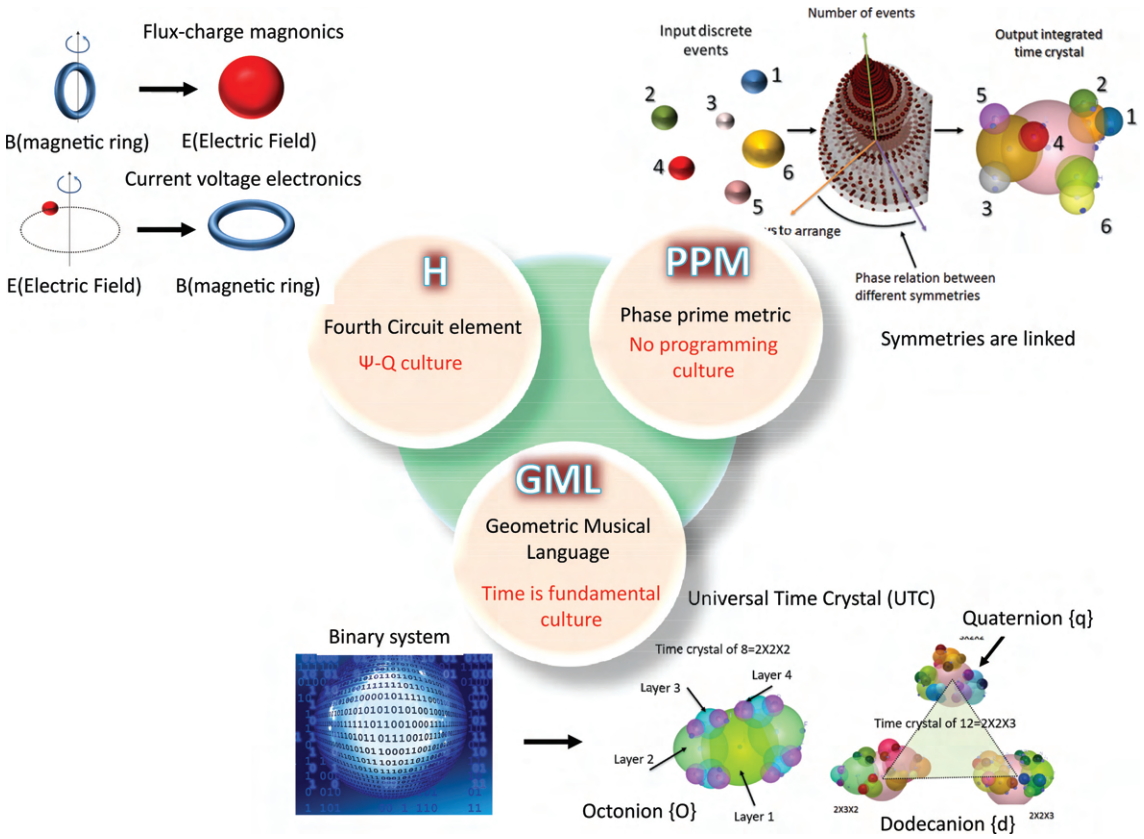

FIGURE 1.9 The artificial brain is based on three fundamental discoveries: First, a new kind of fourth-circuit element, namely Hinductor, *H*. Second, the pattern of primes that links discretely apparent symmetries, which is called the phase prime metric (PPM). Third, geometric musical language (GML), where a special kind of time crystal is used to write information.

microtubule, the water molecules is arranged in a beautiful symmetry of primes. The symmetries of prime are abundant in biology, e.g., in the secondary structures of proteins, along with the DNA spirals, at the smallest scale. Now, as we move toward the larger-size biomaterials or organs, the symmetries of its constituents interact, using octonion or dodecanion tensors to build a higher-level symmetry. Synthesis of symmetry is the key to build a PPM; it is the key to reverse-engineer the brain by synthesizing brain jelly. Apparently, from a dimer of proteins to the layers of the hippocampus and cerebellum, symmetries are composed as primes and generate similar triplet-of-triplet resonance bands in the experiment, which is strikingly similar to the PPM. There is no doubt, nature was perfecting a PPM in the human brain for the last 2 million years, possibly doing the same for billions of years at every part of the universe.

While integrating all the worlds of primes with a chain of vibrations, one should not isolate forces: every single force interacts, and the associated phenomena are simple perceptions of an observer, in the domain of vibrations: nothing is left out—prime loves us. The driving force of such puppetry of primes is the desire of the composition of symmetry for the completeness of PPM; it's hungry to grow from a single zygote in the mother's womb to matching the cyclic rhythms that are governing nature, and it has an ever-increasing appetite. While linking all possible symmetries, PPM is a naturally intelligent analog of the metrics customary in astrophysics, but instead of linking space and time, it links symmetrical breakings of time crystals. The evolution of PPM will continue beyond this book; the objective is to eventually derive a system that refers only to itself, building physics laws from no law (Wheeler, 1980, 1983a, 1985).

Human brain model as a conscious being: The beauty of the time crystal–based brain model is that the consciousness criterion establishes that an element should have at least 12 triplets of triplet resonance bands, so that 3 distinct compositions of bands coexist and operate independently. Since the triangle is a distinct entity, made of $2 \times 2 \times 3$, $3 \times 2 \times 2$, $2 \times 3 \times 2$, it is a superior control of 3 simultaneous, independently editable, complete identities of a conscious being. It was found that the majority of brain elements satisfy this criterion: be it DNA, protein, microfilaments, neurons, cortical columns, or their assemblies, they were experimentally found by biologists for the past half a century to have a typical 3D arrangement of clocks. We simply compile widely distributed reports into a single integrated catalog here. All components share a consciousness as the brain's building block of consciousness (Nowakowski, 2018). Thus, an entire brain turns out to be a timekeeper that primarily manages time crystals of a few femtoseconds to a few million years by adjusting precise motions of the oscillators within the framework of its frequency fractal network. Cognitive behavior is the output of time adjustment by

which external and internal rhythms undergo precise changes at all spatial scales, from a few atoms to the centimeter-scale ranges, to make each other's PPMs similar.

Not just the sensory input, but the pathways or nerve bundles follow a definite geometry and play active roles, infusing time crystals or patterns into a higher-order time crystal (see Chapter 7). The existing models consider that the nerves are mere wires, but in the time crystal model, pathways follow explicit symmetry to build clocks at lower time domains. The story of nerves repeats Tagore and Nowakowski's teaching's narrative (Toolan, 2009; Nowakowski, 2018): not a single loop would exist there unconnected. Such a massive 3D multidirectional clock-composite (Figure 7.15) cannot be linearized into a set of sequential logical rhythms. No software is required to operate it; PPMs have dodecanions with 8 corners or icosanions with 12 corners packed in quaternion statements to help analyze and respond to nature, which is also a PPM.

In summary, all brain components together are a time crystal synthesizer, whose evolutionary purpose is to expand the pattern of primes and acquire the distinct dynamics of new primes—that is, enrich its exclusive PPM. Memory is a time crystal; decision-making is an activation of the linked time crystal. If we generalize, one can encode rhythms of a few million years of periodicity with a cycle that survives only for a trillionth of a second; brain jelly is envisioned to do just that. In a human brain–body system, three time crystals coexist: one, the regeneration time crystal; two, the decision-making time crystal; three, the sensory time crystal. The circadian rhythm or sleep–wake cycle has a time period of 24 hours, proteins a few hours; skin cell replacement rhythms run for two weeks, the bone cell replacement runs for 2–8 years, and the heart cell replacement cycle has a time period of 100 years. Thus, from a single DNA molecule to the heart, everything lives a life and gets replaced by a better one by clock rhythms, and all rhythms are connected by a phase in a 3D pattern of geometric shapes. The artificial brain will not compute following instructions; rather it would be a prime number acquisition device so that its skeleton of primes, its PPM, gets richer. As in Figure 7.15, it would regularly update as more experimental data arrives; brain mapping essentially means "fill in the gaps" of the generic chain PPM. Even a kid can add a few circles to make it more symmetric.

1.10.1 A Language of Time Crystals Written by the Symmetry of Primes

The origin of the geometric representation of events: The matryoshka dolls of Efimov trimer: Two correlated events happening in nature always have a third event as the cause, the triangular correlation of events is fundamental (Reichenbach, 1956). By extending the view of Reichenbach, Price proposed the three-arrows concept (Price, 1996): the cause-effect, the past-future, and the asymmetric time arrow. The beauty of this proposal is that it demands a microphysical symmetry to link the three; Price even started drawing geometric links between the events. Here asymmetric time flows with an architecture of symmetries or a pattern of primes, which evolves as the periodic flow of certain symmetries. Thus, human cognition does not have to link the past to explain the present and predict the future. All are part of an architecture called PPM.

PPM: PPM links the symmetry of events correlated in the universe, which enables us to define events in a way that could be linked to the pattern of primes. Without any human bias, the pattern can predict how events vis-à-vis symmetry would unfold in nature (Courtland, 2018). Thus, without writing code, the metric would analyze how an event would unfold in the future, and what we have missed in the past, if anything. Subevents are interconnected in the shape of a topology—say, like a triangle or pyramid, etc.—to create an event. So, if we express linearly, we lose most of an event's significance.

Say each of the eight corner points of an event with the topology of a cube has unique topological shapes inside. The journey through the corner points, representing the subevents, is endless; events integrate only within and above, not side by side, because if one adds a new corner point to a triangle, we get a quadrilateral. The singular difference in worldview has led us to create a new set of scientific tools described in this book. Instead of using human imagination and logic/memory to link random events and build intelligence, PPM relies on the creativity of the number system, which generates new primes in a new pattern continuously in the infinite integer space $(0,1,2,3\ldots\infty)$. We assume that nature self-assembles the primes to synthesize a new symmetry, thus governs the universe. If we do this with brain jelly, its exclusive PPM can estimate the randomness, predicting the future course of events perpetually. Inventing prime begins at 2 and 3; $2 \times 2 = 4$, $2 \times 3 = 6$...: there is an empty space between 4 and 6, it must be a prime, *let's call it 5!* Similarly, brain jelly can cover 220 million primes for $N = 10^{12}$.

Only 15 primes can generate 99.99% of all integers of infinite number space. So, infinite possible events or shapes can be represented using 15 basic shapes for 15 primes, i.e., a language with 15 letters, like English has 26 letters. One could write infinite possible events as 15 primes, then read evolved unknown primes as the nearest composition of 15 primes. But a computer has to find how, given set of primes, it could test an astronomical number of ways to link participating geometric shapes and converge to one continuously emerging a new set of prime compositions. Since existing computers cannot honor the geometric network of events, we need a new computer that links a set of primes and finds hidden patterns in them by testing all compositions in real-time. A conventional computer cannot do this, because it often requires the following:

1. trial and error for $>10^{23}$ per unit time (however, chemical collisions mimic this routinely in a beaker);
2. 15 primes choose from 220 million primes at a time. Parallelism includes acquiring changes in real-time; no code can interact 220 million nodes at a time (number of primes $<10^{12}$). Parallelism can happen only in a beaker with diffusing and self-assembling clocks.

3. It's impossible to wire all to all, within and above, multilayered imaginary or phase connections; such wiring is possible, however, in the supramolecular synthesis: When 15 prime-based input dynamics are fed to the organic jelly, where one can write a set of primes, one can see the jelly multiply, rearrange, and regroup geometric shapes or the ratio of primes by trial and error and test 99.99% of all possible integers to find a pattern that links input primes and tells us the new sets of primes most probably emerge in the near future. Grouping the primes properly links the input events, a job that a scientist does to build a scientific model, or a programmer imagines to write code. Jelly doesn't follow instructions, but it synthesizes decisions.

1.10.2 A Magnetic Light: Creating a Device That Stores Charge and Builds a Time Crystal

Atoms and crystals made of magnetic light operate as time crystals: In 1984, J. F. Nye proposed to interfere polarized monochromatic light and create dark lines in an empty space where the electric E or the magnetic part B of light disappears. If $E = 0$, we get pure magnetic lines arranged like a thread in the 3D space. Floating threads of pure field lines are not the vortex atoms; they need to be converted into vortices, and only then we can use them as atoms. Different lattice symmetry could initiate the interference of electric and magnetic fields separately. One could create various free particle–like structures made of the magnetic field: some of them look like a ring, some a ripple, some a spiral. It is a major transition from the J. F. Nye work: the synthesis of pure magnetic lines does not happen in open air. Perturbation is injected by a proper design of the device: lines that form on the cylinder-triplets bind and then come out as vortex atoms from the surface, which then could be used for various purposes.

Using charge, one can manipulate the interference condition of a spiral cylinder and create a composition of free magnetic rings rotating clockwise or anticlockwise. So, if one could design a device with the three concentric spiral cylinders, then one could create a phase space, which looks like a hollow sphere with 12 holes all around it. "Hole" means at a particular length, pitch, and ratio of the lattice area of the diameter values; no defined output could be found. The shape acts as a mask: from one side the dark lines fall on the phase space and emit from the other side. When the phase space projects the lines, they bind strings into loops and add a clocking direction to those nested loops. Often multiple strings bind, and a superposition of many rings forms a compound of vortex atoms. A single vortex ring could be an atom, but a composition of rings acts as a crystal.

What we suggest as fiction above is actually implemented as the flux-charge device, known as the fourth-circuit element; the adventure is not new. However, due to the distinct contradictory features with another variant of a fourth-circuit element memristor, the fictional device is named the Hinductor (Chapter 7). The stored pattern of charge distribution can memorize the periodic oscillations of various kinds when a polarized monochromatic light falls on it to read what is written; the distributed charge morphs the electric dark, pure magnetic lines, and forms atomlike vortices, as Kelvin envisioned many years back (Thomson, 1867). Reading a composition of atoms made of magnetic light and immediately finding how delicately the pattern of charges are written on the device is a telling story. Light does not destroy the intricately coupled clocks or periodic oscillation of charges in the device, just reads them as-is and prints it in the open-air 3D space; a magnetic film can read the projected pattern. A time crystal is written into the device by changing the physical shape of the concentric cylinder triplets, following suitable means. Often the suitable mean is using an antenna and wirelessly sending an electromagnetic signal to resonate them. In brain jelly, input information synthesizes an inductor, and the jelly eats time crystals to build H, then self-assembles them to build a higher level H—the process continues.

1.10.3 A Pattern of All Possible Choices to Arrange Primes

Frequency Fractal Computing: Bits of discrete pieces of information are captured in conventional artificial intelligence algorithms. Then human imagination tries to deliver a significance to the dead "bits" and add a sensible logic. Intelligence = number of statements. Our frequency fractal computing hardware has a few 1D, 2D, and 3D geometric shapes stored inside. Since the seed geometric shapes that could assemble to build all other shapes are finite, the quest for geometry in the interactive environment always finds a near or a distant similarity. The most incredible point here is that there is no input from outside; the artificial brain seeks for the existence that governs our universe. It means, for the geometric computing protocol, it does not matter what an object looks like or what the music sounds like, or even the geometric shapes it resembles, or how many features of the music match with its stored ones. The event "searching" that we always do in the current information paradigm never happens inside the artificial brain jelly. In its "spontaneous reply," the entity that holds the answer somewhere in the giant time crystal syncs with any input time crystal absorbed into the network, at all times. Since the brain has only one time crystal, as soon as we try to fuse an input time crystal to it, the spontaneously reply is made immediately; after all, it is the same structure of time. No entity asks questions, no one replies, all entities are geometric, and syncing is the only goal.

When an unknown data flow, PPM-driven GML protocol tries to find the most actively changing regions in the meaningless data structure. In a cube filled with rapidly changing pixels, if the number of rapidly changing points is three and the most silent domains are three, it forms a triangle. All sensors are designed to acquire streams from a singularity and silent communication between the singularity points as part

of a single geometric shape. Moreover, the artificial brain jelly does not look for the existence of geometric shapes. It tries to see how that shape changes into another geometric shape. Thus, in the journey of computing, GML changes what was information totally: we do not acquire factual data, we search for symmetry breaking and how a geometric shape changes. That change is human bias–free, the pure dynamics of a system and the system alone. Then we find how that change repeats: say, a triangle becomes a square and that becomes a pentagon and that becomes a triangle, and the loop continues. Then we draw a circle and put the triangle, square, and pentagon touching the circle perimeter. It is our time crystal. Our information content is actually how symmetry breaks and forms a new symmetry in any system. Thus, a number of bits, flops, speed—learning the well-known computing terms is irrelevant here. We will dip into its rigorous details hereafter.

Creating more than what we know: The second part of the unique feature in computing with primes is that a PPM expands the time crystal obtained from any event happening in nature. Primes are pure: they represent nondeductive symmetry. But an integer space is a deductive map of all possible interactions of primes. When an event is rewritten in the language of symmetry, then since the number of geometric symmetries is finite, PPM can extrapolate the event. PPM generates a map of all possible ways a symmetry could break in the future and might have broken in the past. It means we create an architecture of past, present, and future in the evolved time crystal. The expansion of an event as breaking symmetry in the PPM has several implications. We create information that does not exist; we add features in the future that had no past instances. Thus far, we have documented around 12 different versions of PPM in Chapter 3. The promise for the fusion of finite geometric shapes and finite symmetries is endless.

1.11 CONCLUSION: THE RELIGION OF SCIENCE HAS A TRIANGLE, DARWIN, TURING, AND HODGKIN-HUXLEY

Darwinism argues that the evolution follows treelike branches, the one who is fit survives in the struggle, and the failed ones disappear. Darwinism is applied everywhere, from protein expression to economics (Edelman, 1987). When one argues for an astrophysics-like metric for natural intelligence that maps all possible symmetry breaking in the universe, namely a PPM, it suggests that each prime plants a tree of evolution, and then nature would be a canopy of 15 prime trees: it's not about branches, but a rainforest. There is a collective life of 15 symmetries, not one "it from bit" (Wheeler, 1990); a unit of information holds a reading of a geometric shape, with speed. Turingism argues that irrespective of complexity, every single event that has happened, happening, and would happen in the universe could be written as a sequence of "yes or no" answers to a series of questions. When many people argue about a GML they suggest that irrespective of complexity, every single event that has happened, happening, and would happen in this universe is topological and looks like a pyramid or a cube, whose every corner has an event inside. When we enter inside a corner of that cube or pyramid, we encounter another 3D geometric shape made of events, and the journey is endless. Nature constructs events within and above, not side by side. Thus, a change in the geometric shape that Wheeler envisioned is the closest reality of nature, with a twist that the change in shape is determined by a typical composition of a pattern of prime, PPM. Turing himself talked about the possibility of writing arguments with a pen on a piece of paper. Now, if there are one-to-many connections, then one cannot cut those arguments and glue them to make a Turing machine. This takes us to a new world of computing, where Gödel's incompleteness (Gödel, 1938, 1947) and Russell's paradox come into action ($1 + 1 = 2$, in a box; where the second 1 comes from, if we start from one 1; Russell, 1901, 1948). The third religion of science is Hodgkin-Huxley, which suggests that all cognitive information in a neuron is processed by its skin; neuroscience is dermatology of membranes. The early historical roots of the field can be traced to the work of people such as Lapicque, Hodgkin and Huxley, Hubel and Wiesel, and David Marr, to name a few. Lapicque introduced the integrate-and-fire model of the neuron in a seminal article (Lapicque, 1907). Since then, ion diffusion and membrane potential regulate the core of cellular biology; thousands of concretely packed nanostrings of protein remained an uncharted territory, until we listened to their music. Even now, the neuron is just like a balloon, ions move to create membrane potential flow, and the whole system inside is silent. Nanotechnology reveals that every single component starting from alkyl and amino groups of proteins or DNA to the largest organ, the skin, forms a time crystal architecture, a network of clocks from femtoseconds to hundreds of years. This time crystal model of a human brain is the foundation of the nanobrain (Chapter 7).

Let's begin our journey with Leibniz (Leibniz, 1956): "Although the whole of this life was said to be nothing but a dream and the physical world nothing but a phantasm, I should call this dream or phantasm real enough if, using reason well, we were never deceived by it."